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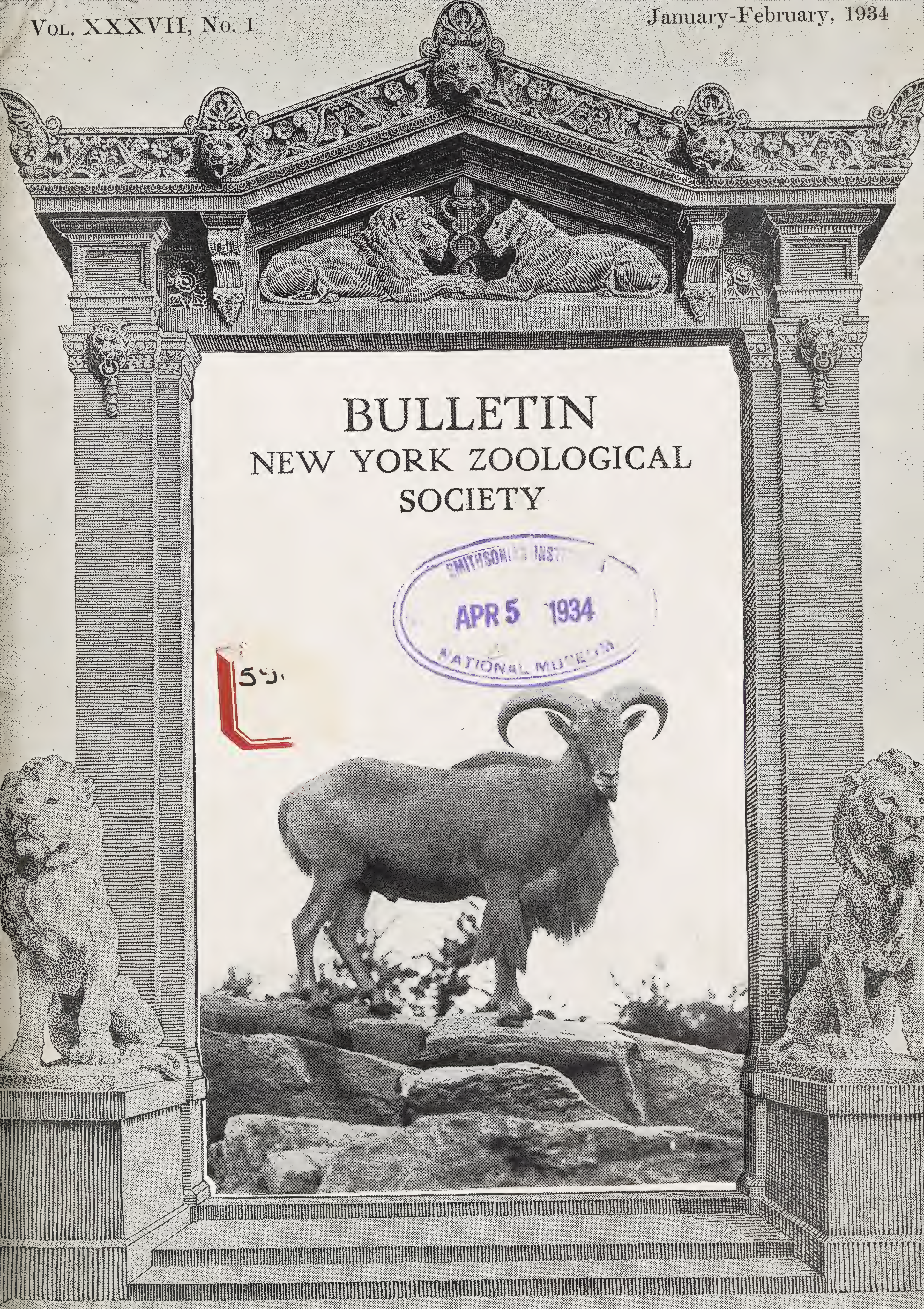

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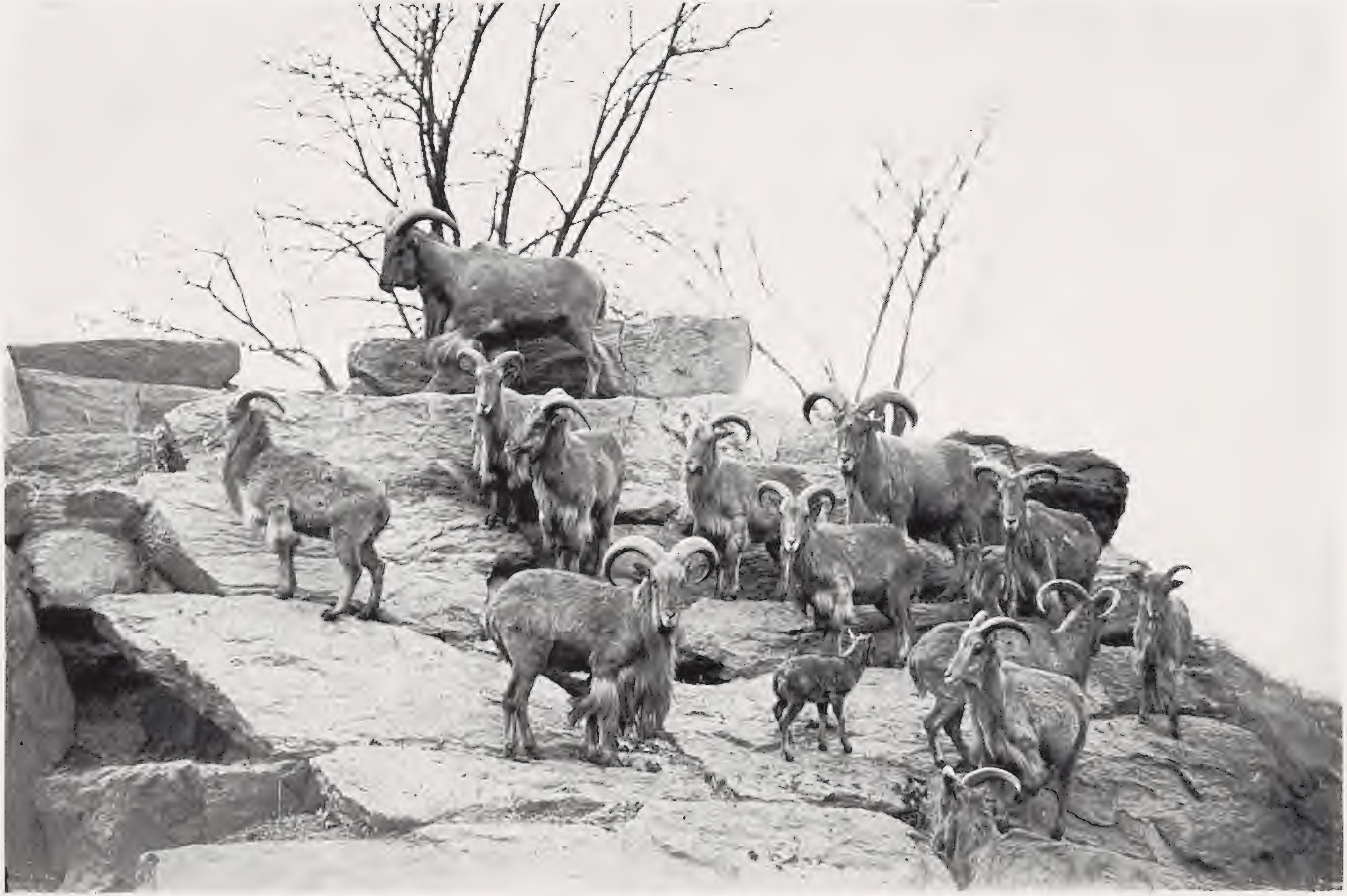

The herd of aoudads (Barbary mountain sheep) in the Zoological Park. If all animals thrived as well in captivity as these representatives of a foreign clime we would be greatly overstocked. There is always something new on the aoudad section of Mountain Sheep Hill.

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Wild Sheep, Goats and Rock Antelopes

Claude W. Leister
Curator of Educational Activities, New York Zoological Park.

Illustrated by photographs made in the Zoological Park and from specimens in the National Collections of Heads and Horns

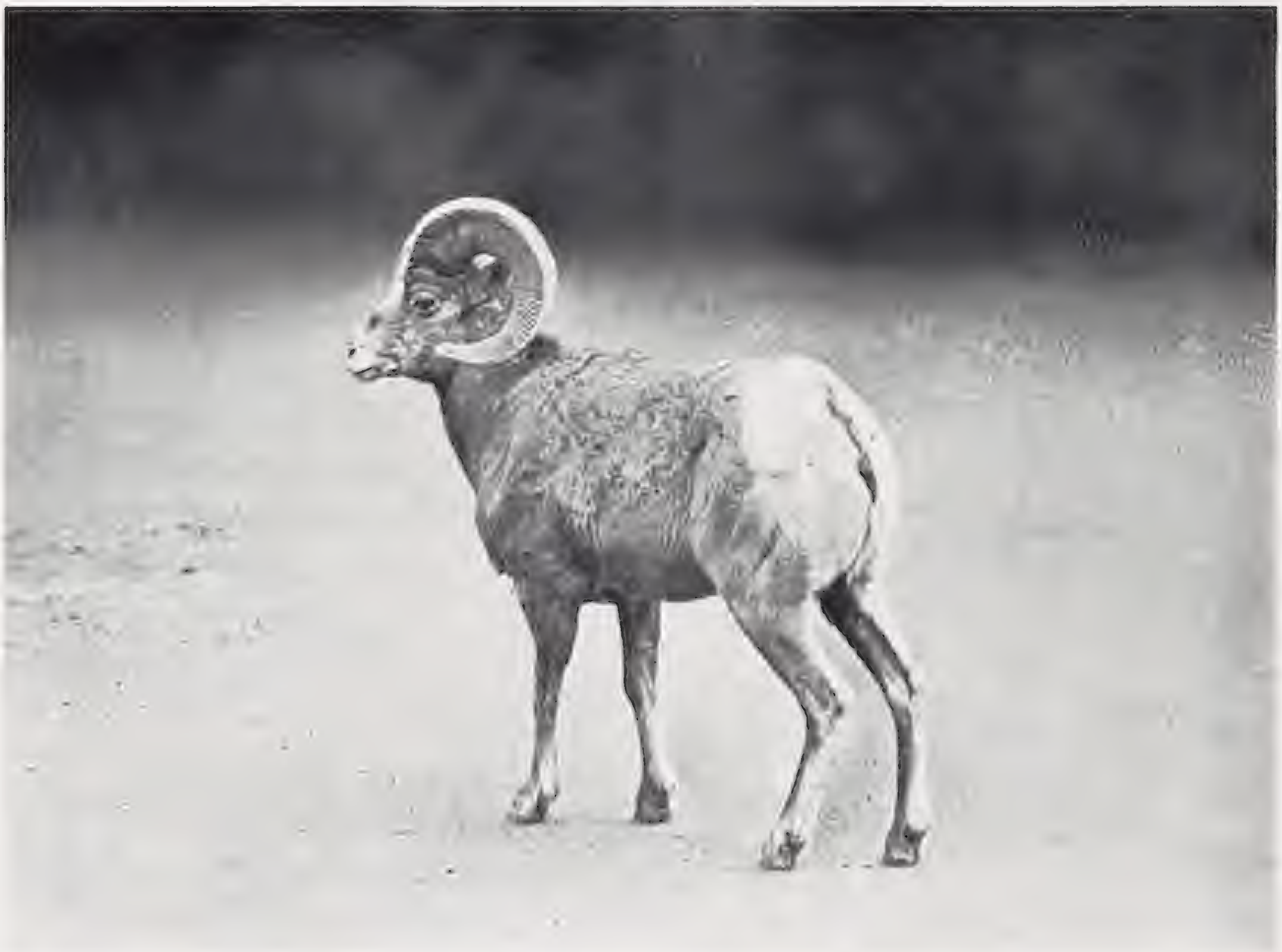
In its collection of hoofed animals a Zoological Park offers an interesting opportunity for the visitor to compare familiar domestic varieties with their fore-bearers and relatives of the wild. Unfortunately, due to quarantines and embargoes designed to prevent the spread of disease, and the ever increasing rarity of these animals in a wild state, such exhibits are more and more difficult to obtain. The New York Zoological Park maintains a representative collection of hollow-horned hoofed animals, and an additional opportunity to examine some of the rarest species, which have never been exhibited alive, is afforded by the specimens in the National Collection of Heads and Horns.

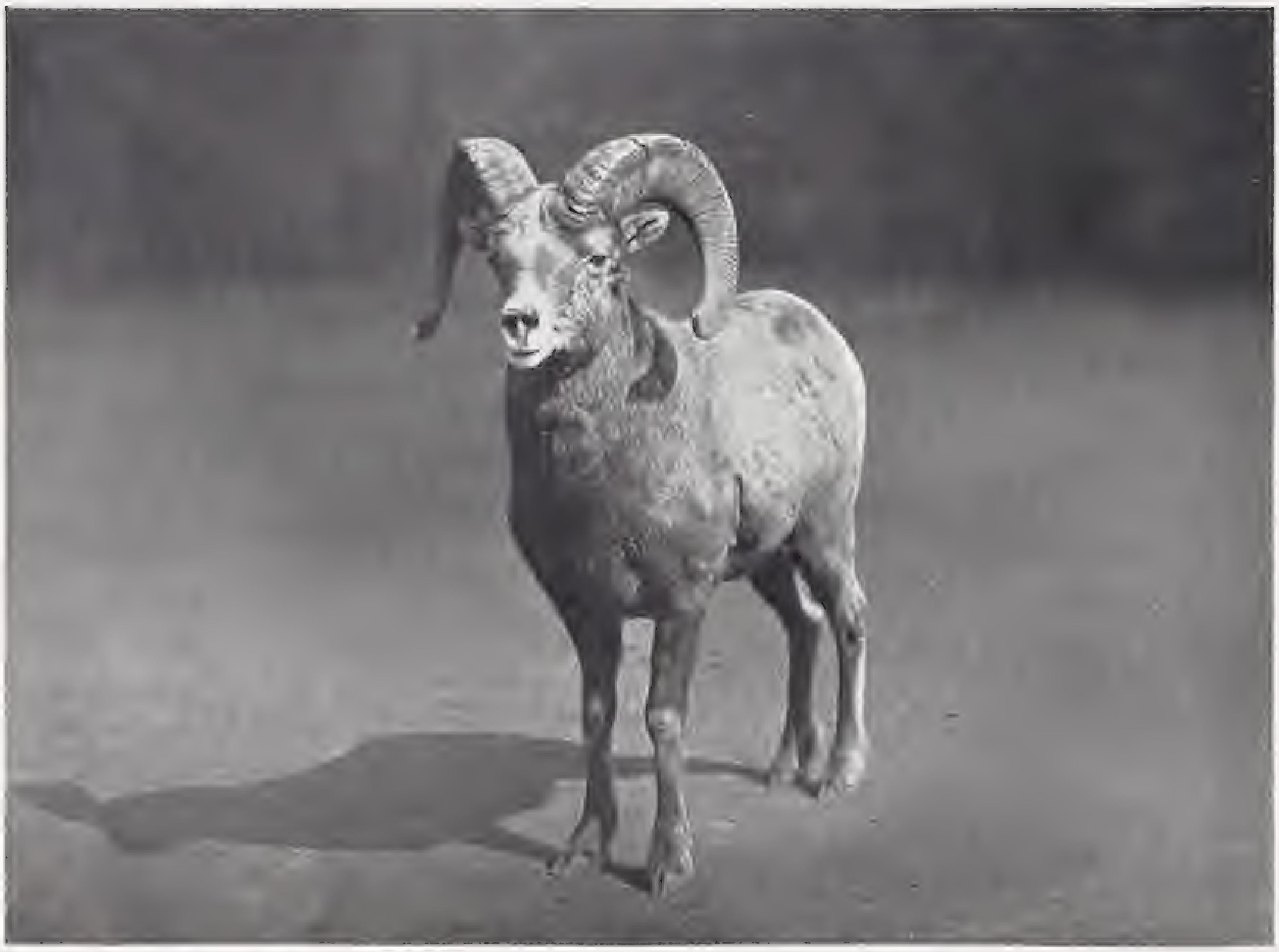
The family *Bovidae* contains a number of lesser, well-marked divisions or sub-families. One of these, the *Caprinae,* contains the sheep and goats and is the subject of our present discussion. These animals are connected to each other by plainly evident relationships, but their relation, that of sheep especially, to other members of the family is not so evident. Because of certain structural characteristics shared in common with antelopes, and since there seems to be no close affinity with cattle, it can safely be presumed that both sheep and goats evolved from some early antelope ancestor.

The group (*Caprinae*), is not an ancient one from a geological standpoint, and in North America no fossil remains of either of the typical genera, *Ovis* or *Capra,* have been found in the Tertiary deposits, and remains of our present-day bighorn sheep have been found only in the late Pleistocene. Goats have never reached North America. In this connection it will be remembered that our so-called mountain goat is not a true goat.

The ancestral home of both sheep and goats may be located in the mountains of Central Asia, and today that region is still their stronghold. There has been a general dispersal of representative species along the closely connected mountain systems of the world, with the exception of the outlying continents of Africa and South America.

Since they are of such recent origin, neither sheep nor goats have been greatly changed through evolution. All of them are still essentially mountain dwellers. "No species frequent by choice either level deserts, open plains, dense forests or swamps." Thus in North America, having neither the time nor the inclination to do so, the bighorn sheep has never crossed the great central plains region to the Appalachian mountain system of the east, and in its spread southward has never reached South America, extending no further than the mountains of Mexico and Lower California. Only two species, the aoudad and the ibex, are to be found in Africa, and they occur in but a small portion of the northern part. Not a single species has been





Two fine specimens of the Rocky Mountain sheep or bighorn. These photographs portray this North American sheep to good advantage. Note the stockily built body and the gracefully curled horns. The upper figure shows the characteristic lighter-colored rump patch.

able to cross the great Sahara, or the intervening tropical forests, swamps and plains, to the mountains of South Africa. Sheep are northern animals and with one or two exceptions have never penetrated the tropics, where they have done so their habitat is, of course, confined to the mountains. Goats do not range so far north as sheep, nor did they do so in earlier times and thus were not in position to enter North America by the land connection then existing in the Behring region, the route followed by the bighorn sheep.

Both sheep and goats have been domesticated since very early times. The origin of the domestic sheep is lost in antiquity and possibly several races of wild sheep were the fore-runners of our present-day domestic breeds. The Swiss lake dwellers possessed sheep but they were totally different from any of the wild species living today. The domestic goat (*Capra hircus*), was first described by Linnaeus from a Swedish specimen. It is most like the Persian wild goat, although undoubtedly many crossings with other wild species were made during the early period of domestication.

The horns of wild sheep are more or less triangular in section and while they may be spirally curled they are never arched over the back. With the single exception of a race of the mouflon, where the females are hornless, both sexes of all wild sheep possess horns, although those of the male are considerably the larger. In some domestic breeds, such as the Dorset, both sexes have horns, but in the majority of them the males alone bear these appendages. There is usually a small gland on the face below the eye and between the hoofs of both fore and hind feet.

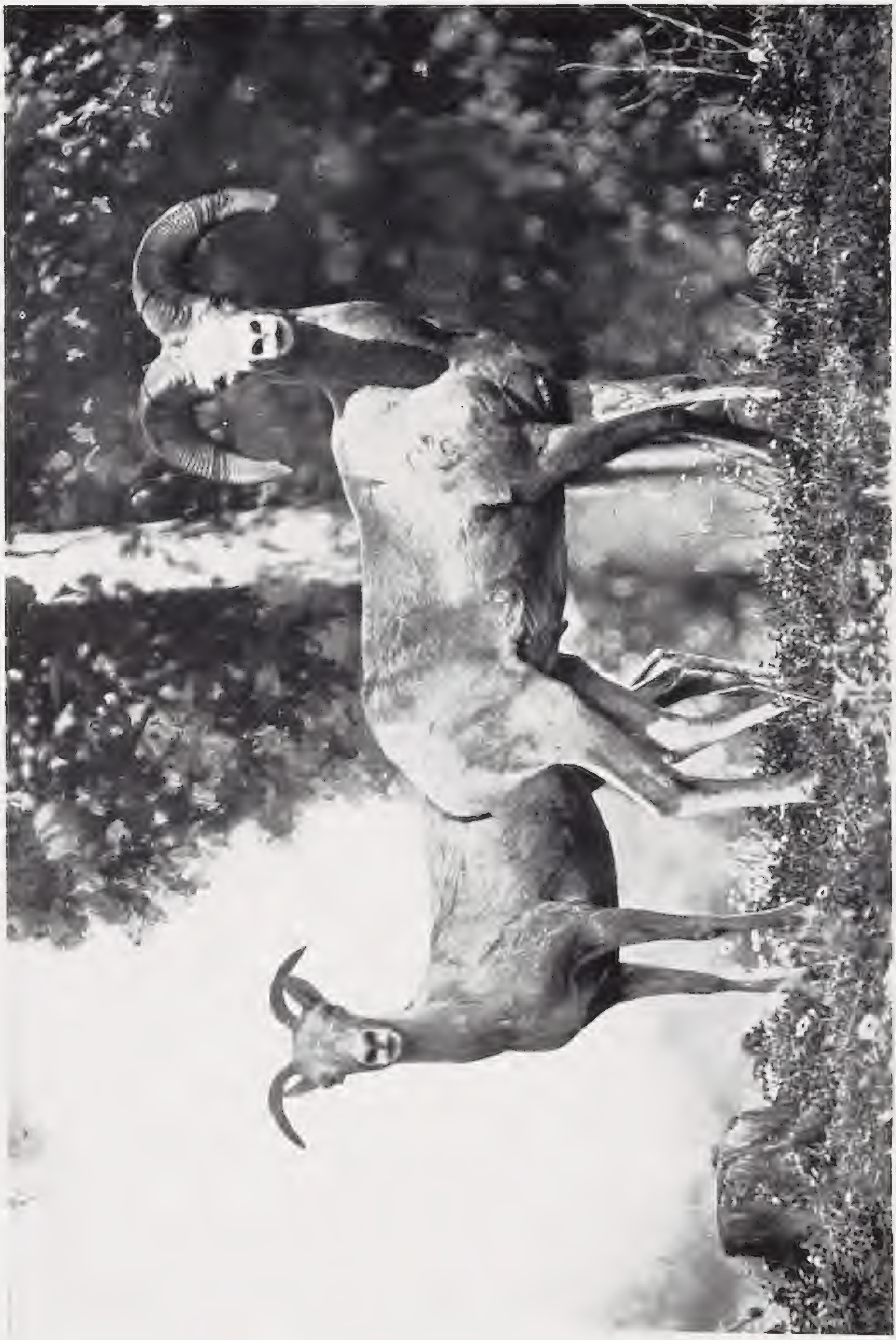
It is interesting to note that no wild sheep bears a coat of wool. Wool, as we are accustomed to see it on domestic sheep is a product of domestication and has been developed through selective breeding. Some wild animals, especially fur-bearers, possess two distinct coats of hair. There is an outer coat of long, rather coarse hair which serves to protect from wear and tear an undercoat of finer, more or less woolly hair. In the domestic sheep the undercoat has been excessively developed and the guard hairs have disappeared.

Goats (including ibexes and markhors), are very similar to sheep although, unlike the latter, they do not have a gland below the eye, nor do they possess glands between the hoofs of the hind feet. The males have a strong odor and generally a beard. The horns are usually round in section and, in the long-horned species are never spirally curled outward but sweep over the back. Ibexes have long, scimitar-shaped horns, carried in a graceful arch over the back. The front surface of the horns is decorated by a series of regularly spaced, transverse knobs. Markhors have spirally twisted or turned horns, the spire being either open or closed.

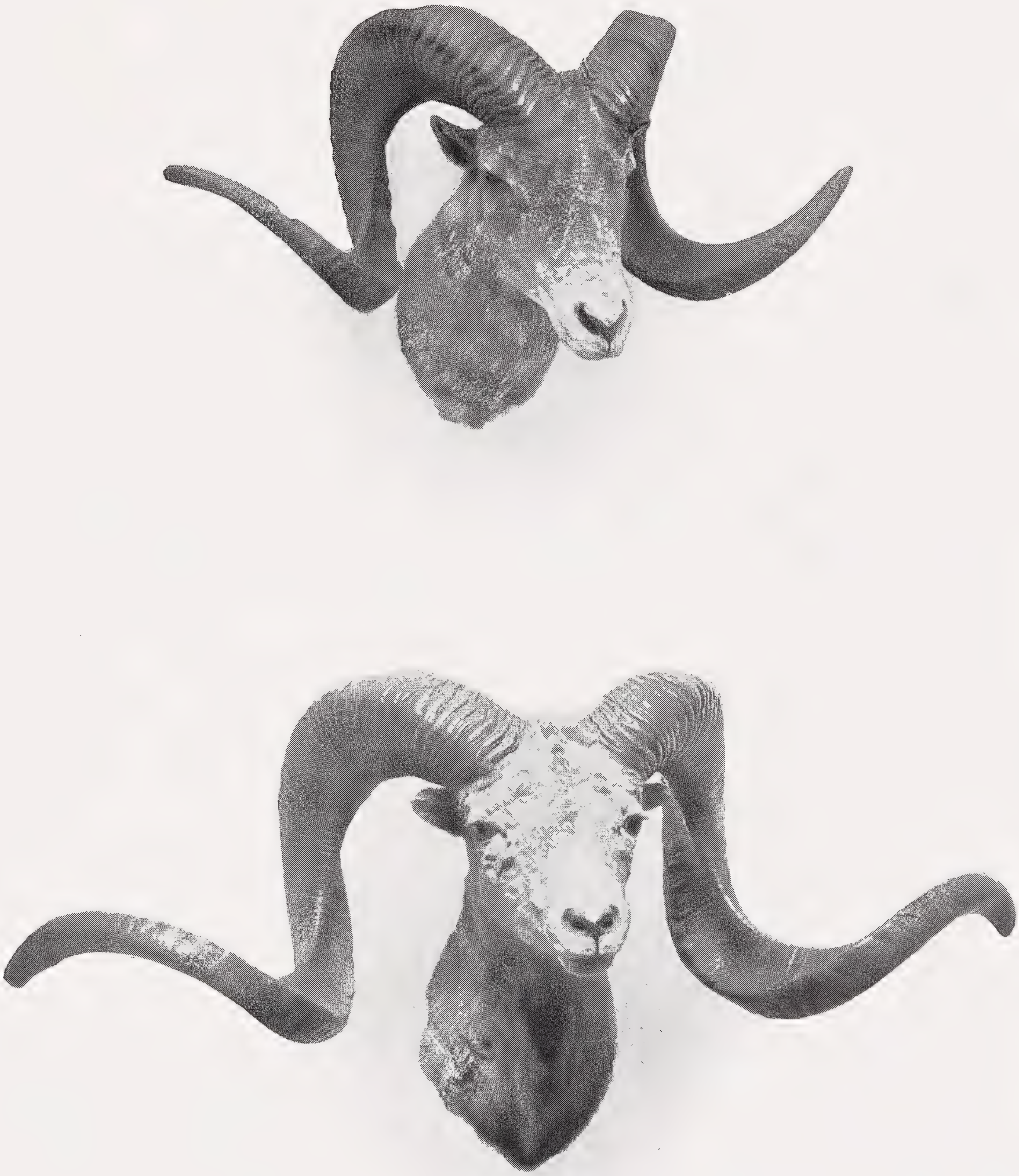
Wild sheep are usually found in small bands consisting of a number of ewes and their young. During the greater part of the year the rams are more or less solitary, go about in small groups by themselves, and are found with the flock only during the breeding season. At that time each ram strives to hold together a coterie of females as his own, and numerous fights result. In fighting they not only fence with their horns but meet in vicious, head-on charges that only the thickest of skulls and strongest of neck vertebrae could withstand. The loser retires as gracefully as possible or else, perhaps, is pushed over a cliff to his death on the rocks below.

Some species, mountain sheep especially, are remarkably wary and possess a keen sense of sight and smell. Because of their habit of frequenting exposed and inaccessible areas, usually with some member of the band standing watch, they are exceedingly difficult and well nigh impossible to approach within short ranges. Hunting these sheep requires a considerable amount of skill and physical ability and even the hardiest sportsmen pursue them with varying degrees of success. Other species are not particularly wary and the difficulty in hunting them is due to the remoteness of their habitat and the ordinary hardships of the chase that are to be encountered in such localities.

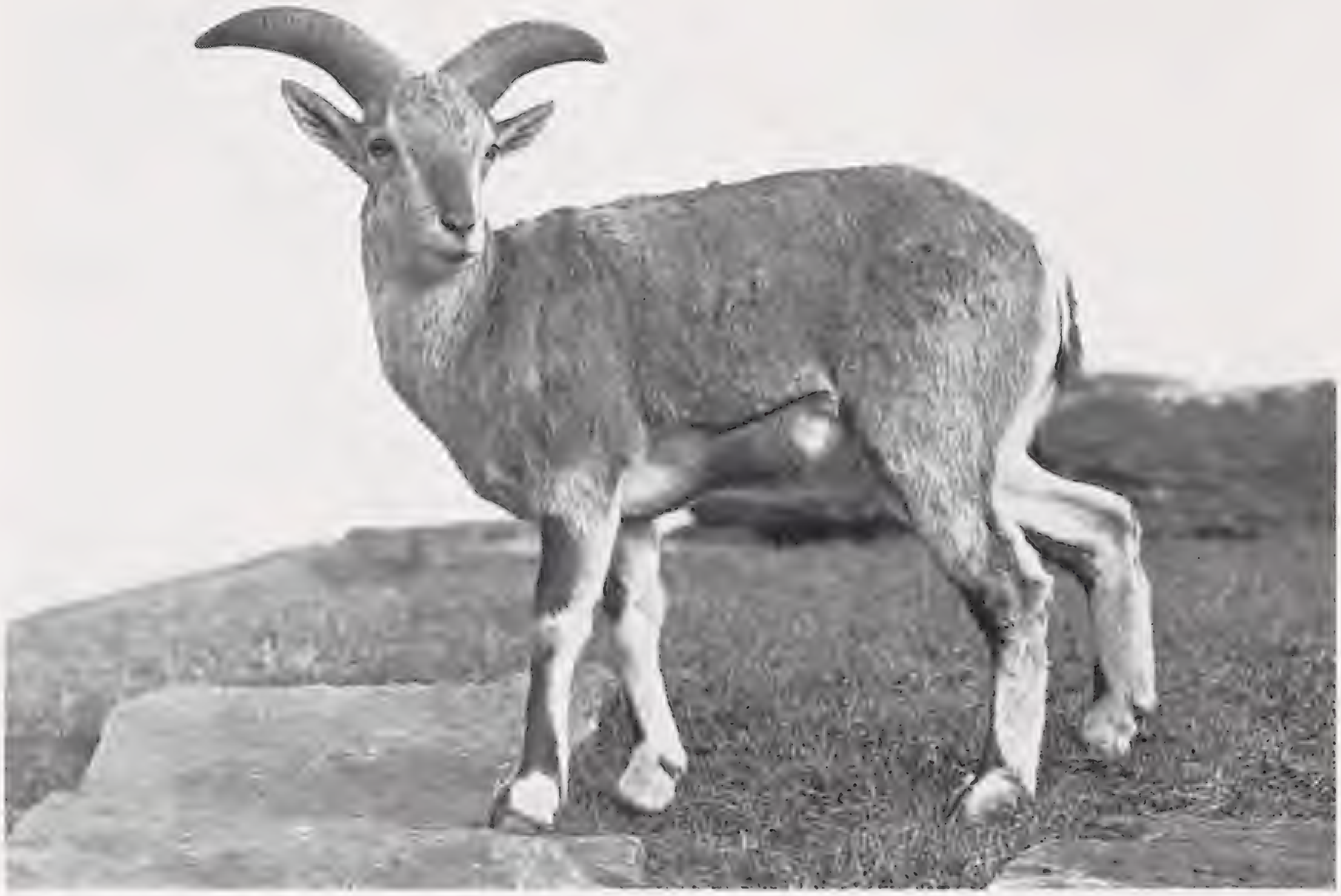
Generally speaking, goats are better mountaineers than sheep and most species inhabit the roughest of mountain regions. Like sheep they congregate in small bands, composed of ewes and younger rams, the old rams keeping apart by themselves, in some species staying at higher altitudes and above the snow-line, and associating with the herds only during the breeding season.

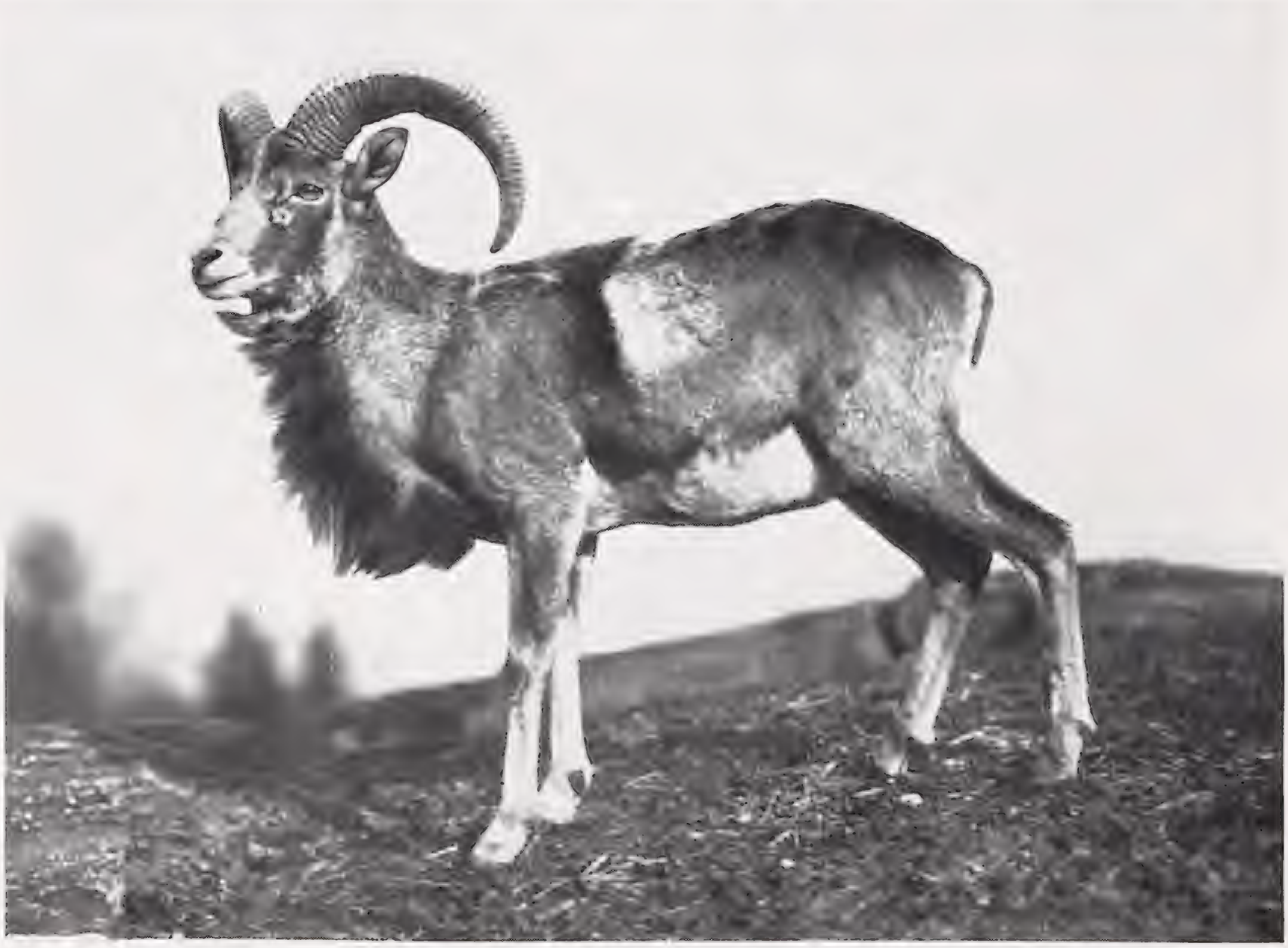


A bit of the wild transported to the Zoological Park. A pair of bighorn sheep on the alert. Both sexes of wild sheep usually possess horns but those of the females are small and poorly formed, never seriously rivaling the handsome structures borne by the male.



Two of the world's finest trophies of the chase. Representatives of the argalis, Asiatic mountain sheep closely related to our bighorns. Littledale's argali above, Marco Polo argali below. None of the argalis has ever been exhibited in any of our American Zoological Parks. From the National Collection of Heads and Horns.





Two Asiatic wild sheep. Above, the burrhel or blue mountain sheep from Central Asia and Tibet. Below, the Punjab urial from India. The former animal is seldom seen in our Zoological Parks.

Sportsmen have always taken a great interest in hunting certain sheep and goats, especially the argalis, the bighorns and the markhors. It follows that considerable popular interest has developed concerning these animals.

The bighorns or Rocky Mountain sheep are well distributed over the Rocky mountain region of North America and two races occur in similar country of north-eastern Asia. Their most evident characteristic is their massive, curled horns. While formerly found in relatively open country they have been hunted so assiduously that they now occur only in the higher and more inaccessible ranges. There are several species and races. Typical *canadensis* is grayish brown in color; *dalli* is white; and *stonei,* sometimes called the black sheep, is a blackish brown. Bighorns are agile, wary and excellent climbers.

The argalis constitute an interesting group of sheep from the mountains of Central Asia. In general appearance they resemble our bighorns but are slightly larger, being the largest of the sheep. The horns are more strongly marked by ridges and the tips have a stronger tendency to grow outward. The best known species is the Marco Polo argali (*Ovis ammon poli*), from the Pamir plateau. This sheep was first described in the travels of Marco Polo but was unknown to science until 1838 when the first specimens were brought to England. The romance attached to this sheep and its massive and wonderfully curled horns have caused it to be one of the most sought after trophies in the world. The weight of a large ram's head has been recorded at forty pounds and the neck of the sheep is unusually strong in order to support this weight. The Marco Polo sheep formerly occurred in the Pamirs in great numbers where it is said that as many as six hundred have been seen in the course of a day's hunt. It frequents open plateau country rather than the mountains.

Markhors are in many respects the most remarkable of all the wild goats. Their horns are spirally turned or twisted in a cork-screw-like fashion. In the Astor race (*Capra falconeri falconeri*), the spire is open, while in the Suleman (*Capra f. jerdoni*), it is tightly closed, forming what is practically a straight horn with spirally turning ridges. In the other races the horns are intermediate between these extremes. Sportsmen look upon the horns of the markhor as one of the most highly prized trophies of the chase.

Rock Antelopes

Another sub-family of the *Bovidae,* the *Rupicaprinae,* contains a number of goat-like animals called rock antelopes or goat antelopes. The various members of this group are commonly regarded as being goats but in reality they are more closely related to true antelopes. Two well-known representatives are the mountain goat, from the Rocky Mountain region of northwestern North America, and the chamois, from the mountains of southern and central Europe. The remaining members are the takin, goral and serow, native to south-eastern Asia.

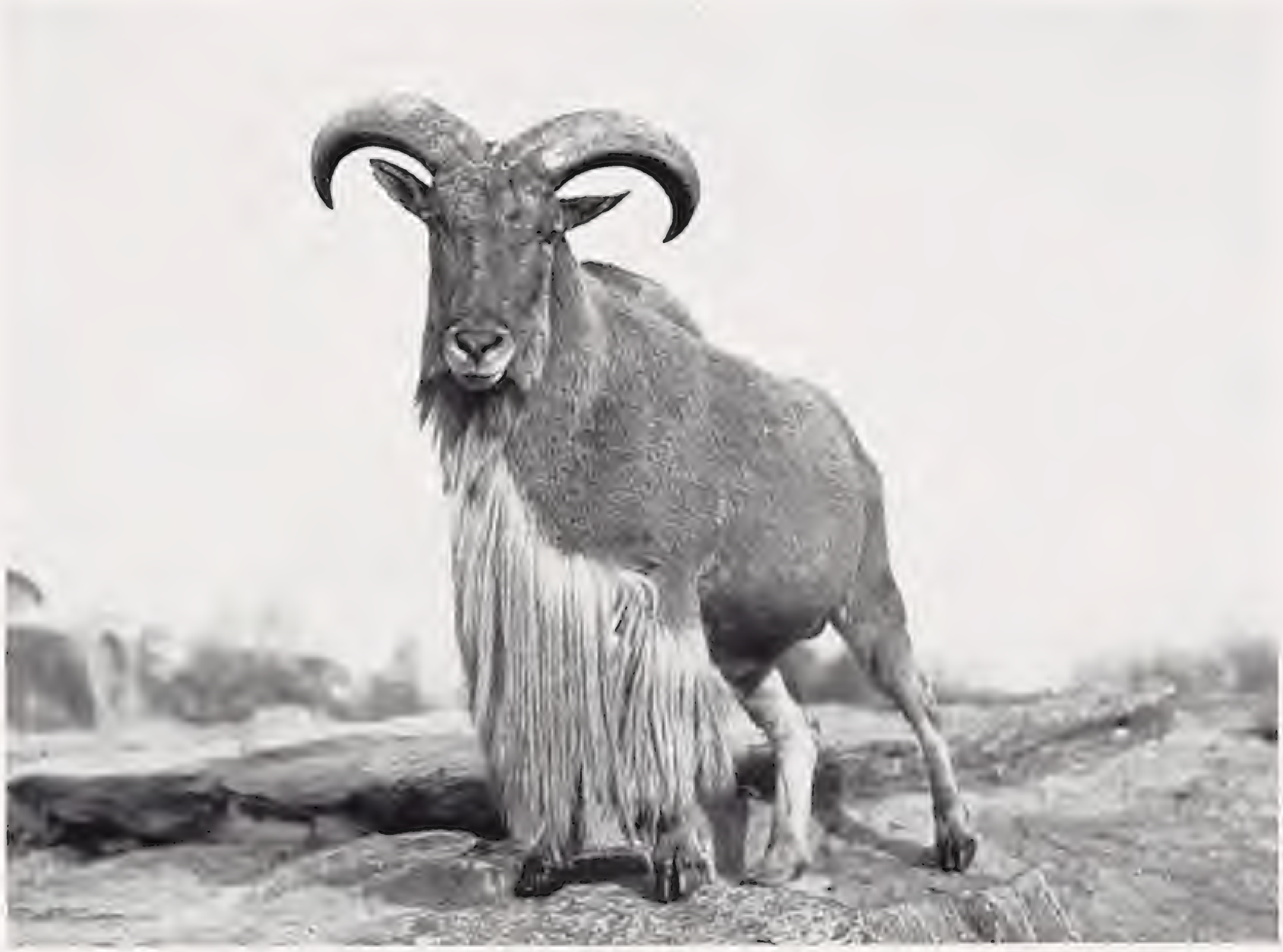
The *Rupicaprinae* form more or less of a connecting link between goats and antelopes. Members of the group are somewhat goat-like in form but their horns, which are more like those of antelopes and relatively small in comparison to the size of the animal they adorn, are slender, moderately curved and generally black in color. The horns of the chamois are abruptly curved at the tip, while the takin's resemble those of the gnu.

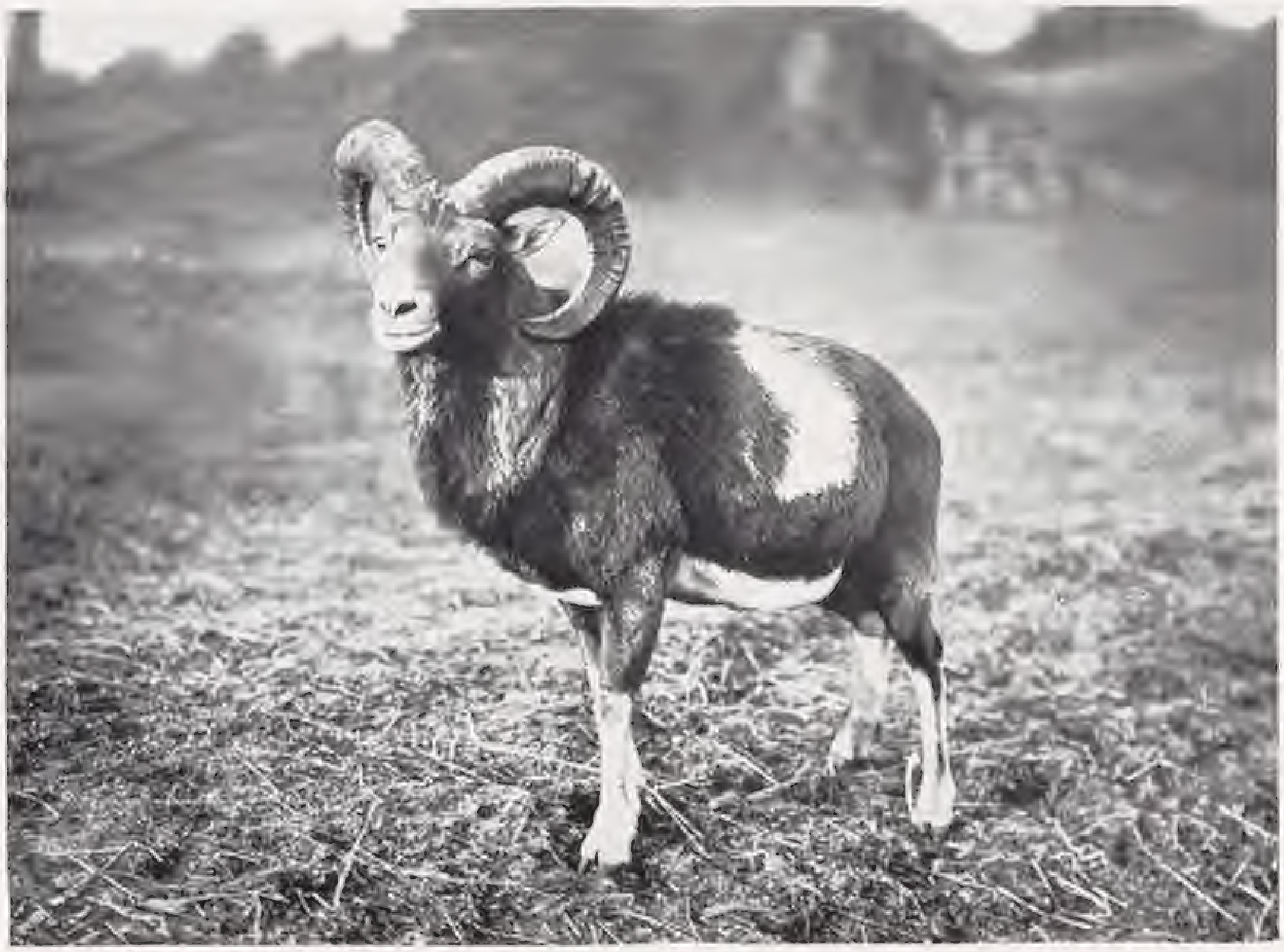
There is a great variation in the size and color of the various rock antelopes. The takin weighs about three hundred pounds while some gorals and the chamois weigh only sixty. The mountain goat is white or whitish in color and several races of the goral are almost black. The mountain goat, chamois and gorals possess a woolly underfur, the serows a crest of long hair along the back.

In North America, the mountain goat, like the bighorn sheep, is evidently a late immigrant from Asia, having crossed the Behring land bridge which existed during the middle Pliocene. In spreading southward it never extended its range very far beyond the northern boundary of the United States and therefore never reached South America.

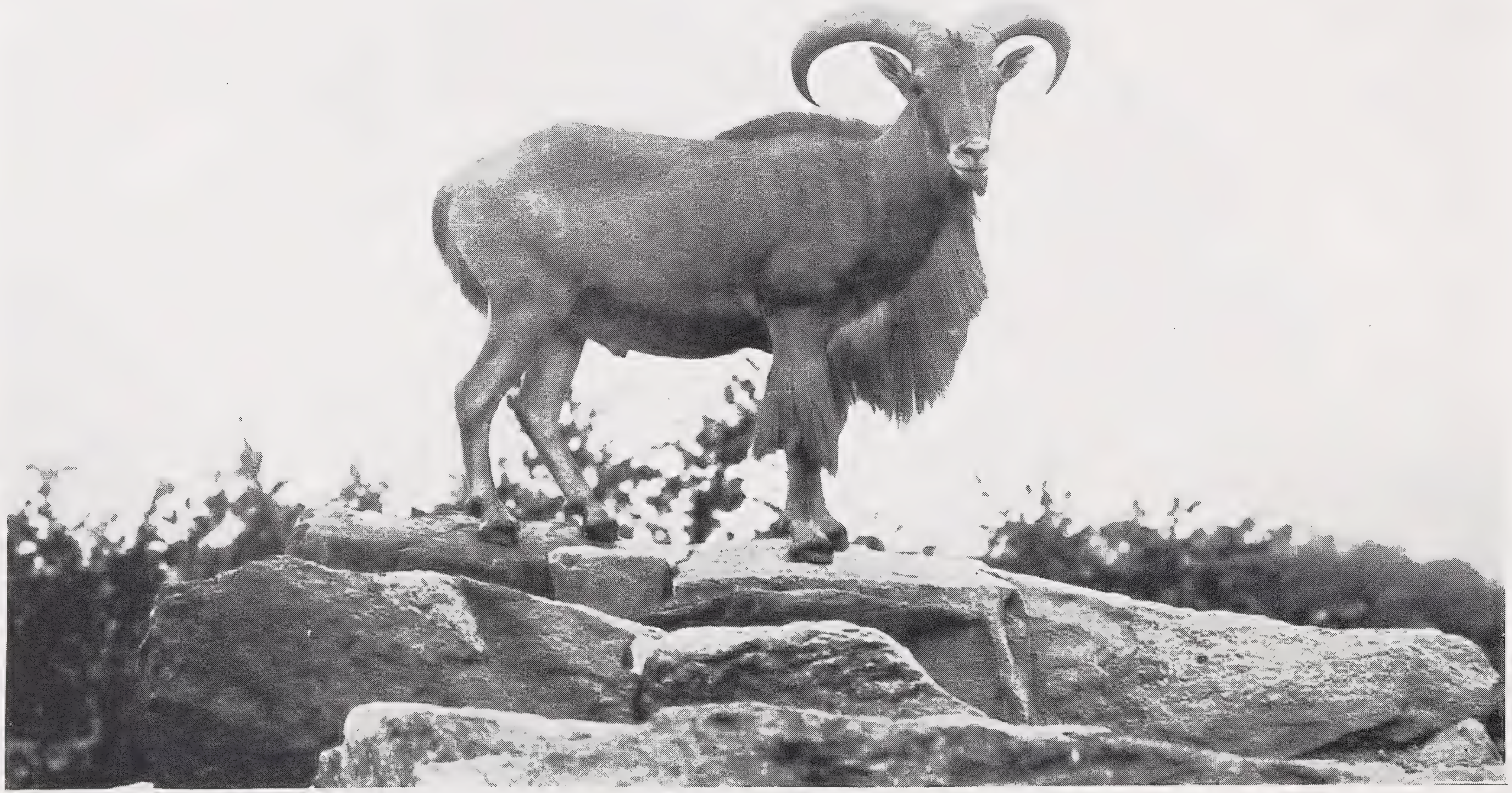
Members of the *Rupicaprinae* are not particularly wary, on the other hand they are sometimes regarded as being rather stupid, possibly because they have learned to rely so implicitly upon the general safety from intruders afforded by the inaccessibility of their domain. They are sturdy climbers. Our mountain goat,

The mouflon herd at the Zoological Park. A characteristic winter scene on Mountain Sheep Hill.



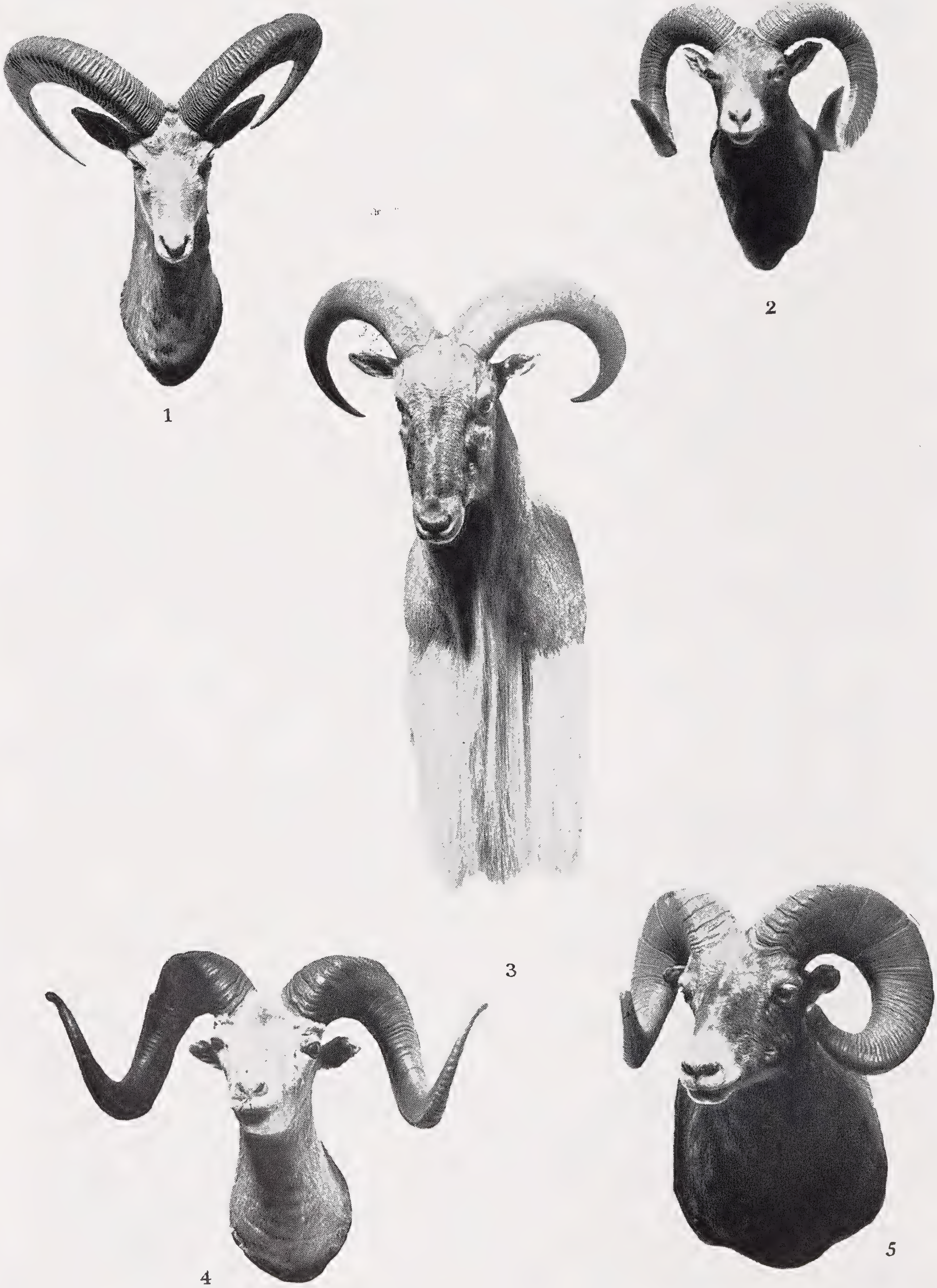


Old male aoudads possess a striking adornment in the fringe of long hair which extends from the throat along the middle line of the neck to the chest where it divides and continues along the upper part of the fore limbs. Several other sheep exhibit this tendency which is shown here at its best development. Below, a fine mouflon, the leader of the Park herd.

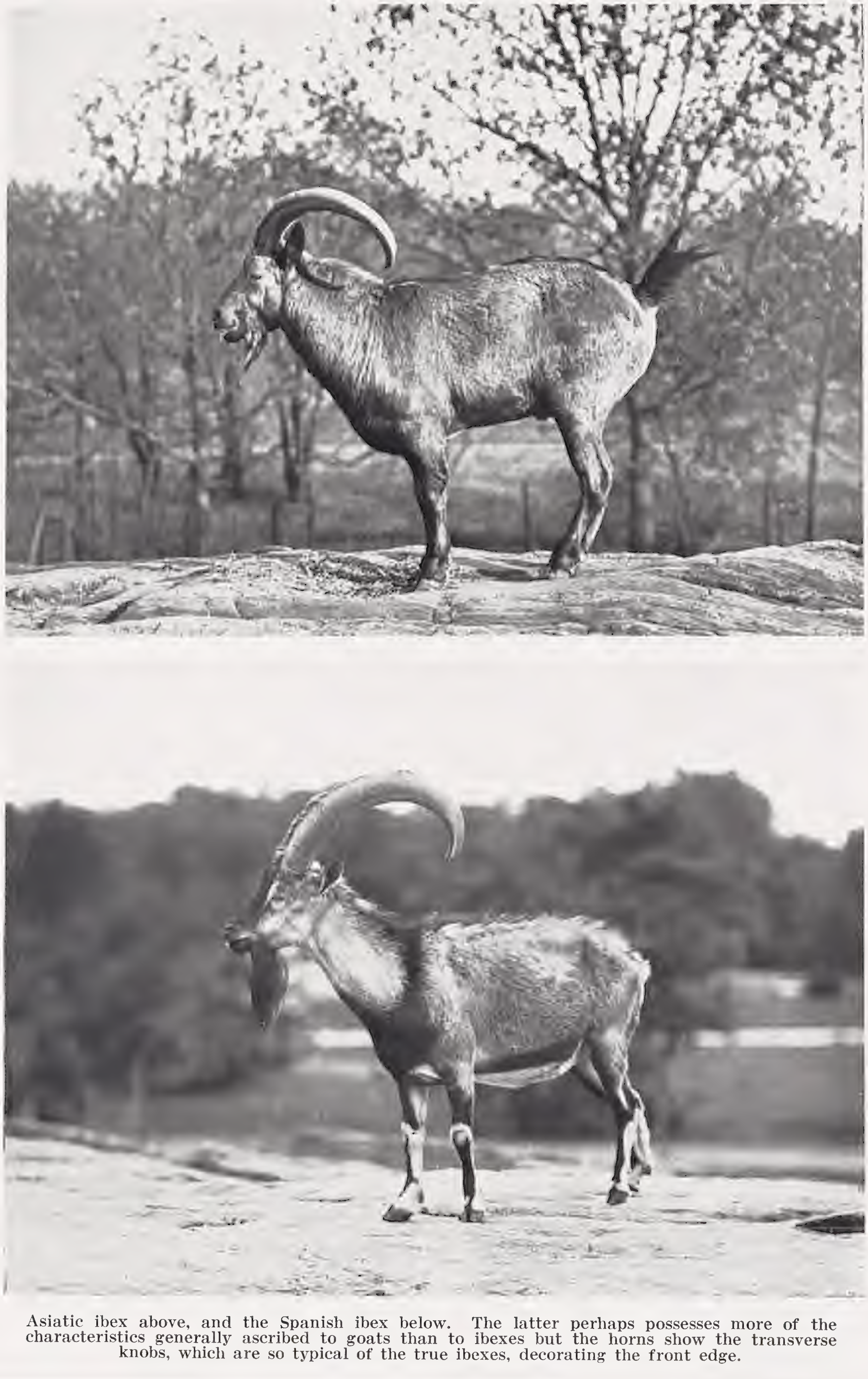


An excellent portrayal of the statuesque aoudad. This animal is younger than the individual shown on the preceding page and his hirsute adornments have not attained such a luxurious growth. The scene might well be in North Africa but the photograph was taken in the Zoological Park.

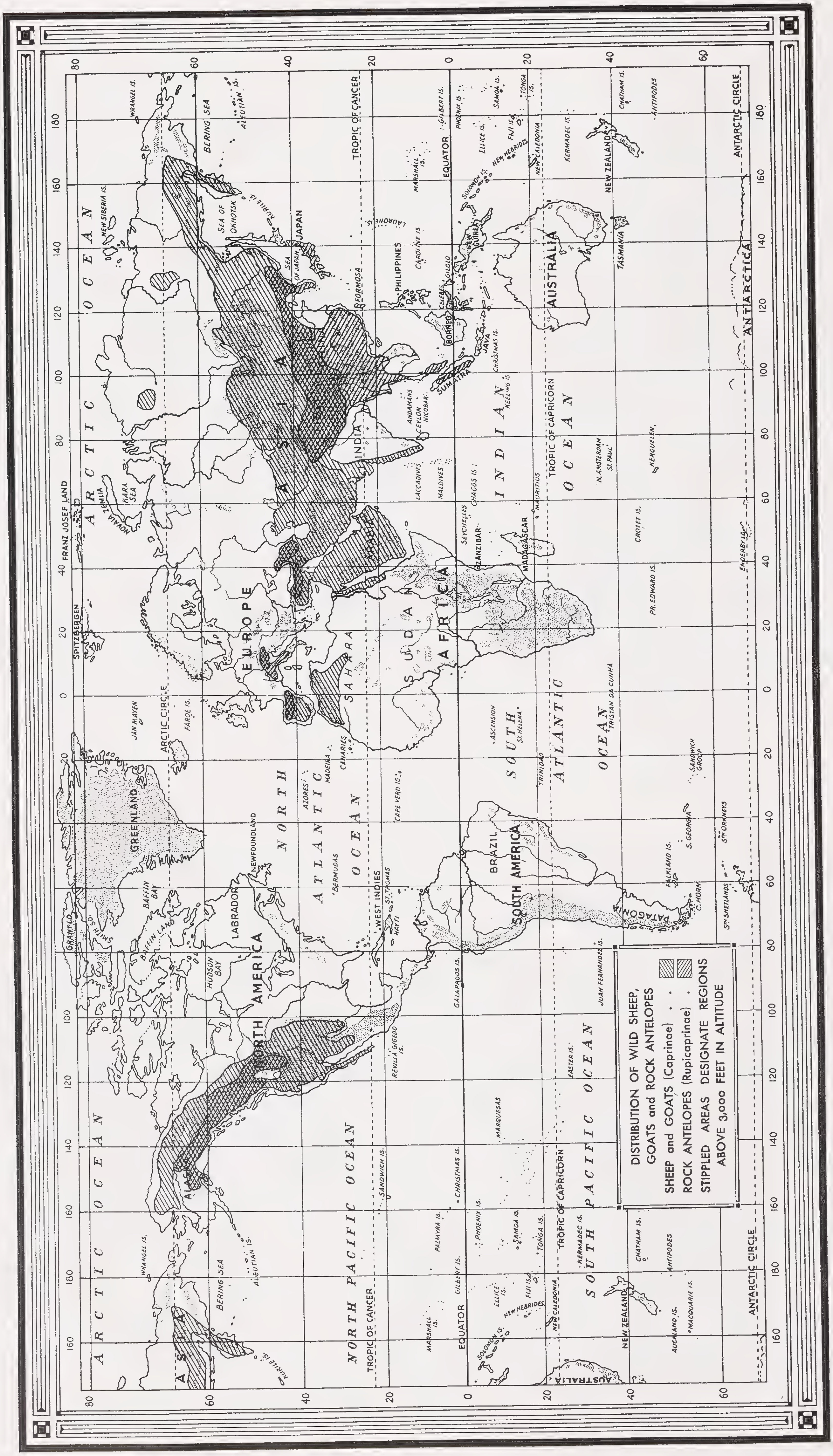
Aoudads are good climbers and like to occupy an elevated perch from which they can look out over the surrounding territory. They are here shown on the roof of their shelter-house at the base of Mountain Sheep Hill. Below, a family of Punjab sheep. Our present male is seemingly a friendly sort and receives many a tid-bit from visitors to the Park but workmen, whose business causes them to enter his corral, will tell a different story.



Various sheep of the world. (1) Ladak sha, (2) mouflon, (3) aoudad, (4) Dall's sheep: white mountain sheep, (5) bighorn: Rocky Mountain sheep. From the National Collection of Heads and Horns.



Asiatic ibex above, and the Spanish ibex below. The latter perhaps possesses more of the characteristics generally ascribed to goats than to ibexes but the horns show the transverse knobs, which are so typical of the true ibexes, decorating the front edge.



DISTRIBUTION OF WILD SHEEP, GOATS and ROCK ANTELOPES

SHEEP and GOATS (Caprinae) . . ▧

ROCK ANTELOPES (Rupicaprinae) . ▨

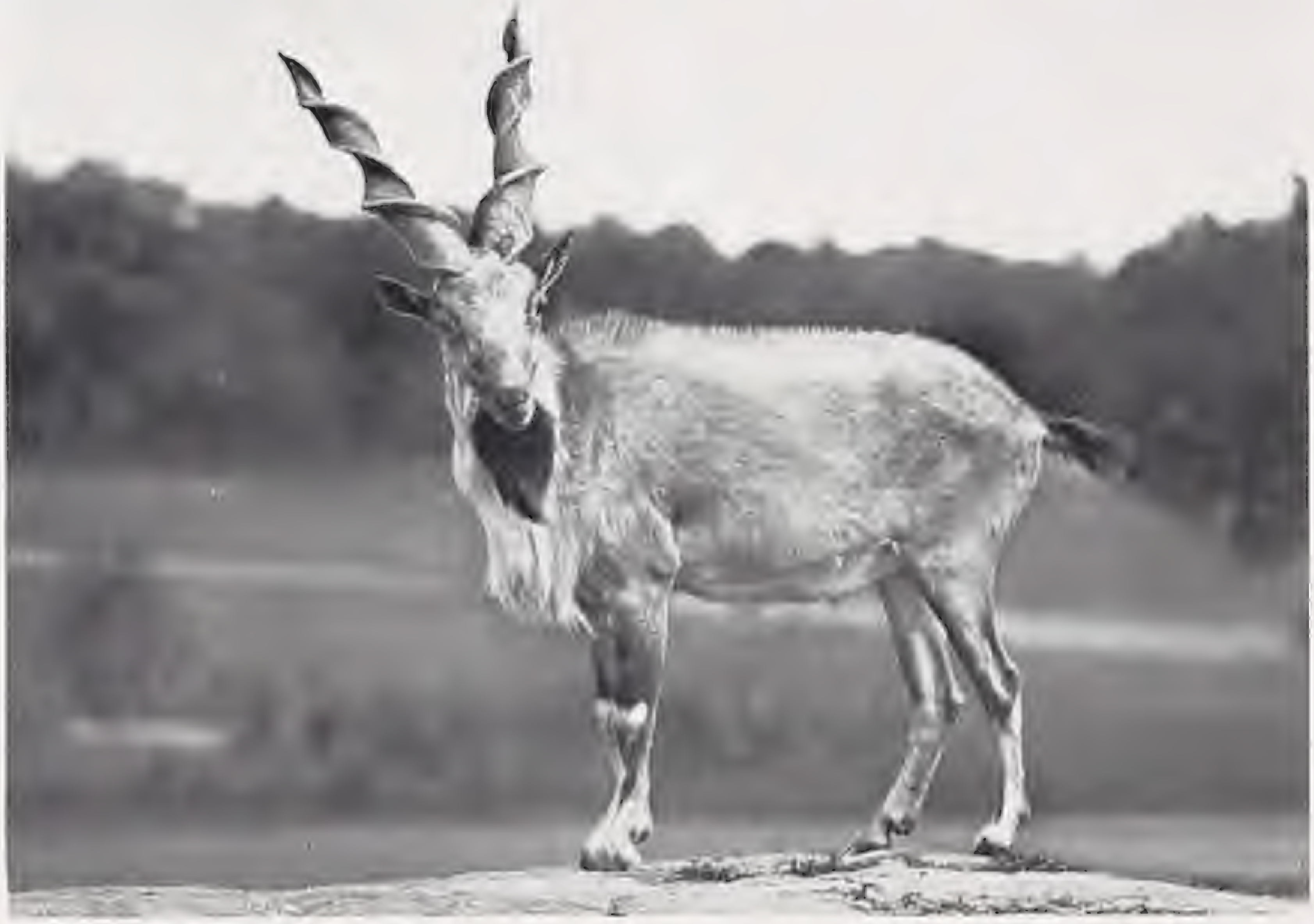
STIPPLED AREAS DESIGNATE REGIONS ABOVE 3,000 FEET IN ALTITUDE for instance, is neither agile nor fleet of foot, but it is entirely at home among precipitous cliffs and broken rocks, and at the approach of danger slowly but surely makes its way over narrow shelves and ledges to heights where few other animals can follow. The chamois is apparently the most agile and wary animal of the entire group. Its leaping powers are legendary and in old engravings it is sometimes portrayed leaping from crag to crag and across yawning voids with an abandon that completely ignores the laws of gravitation.

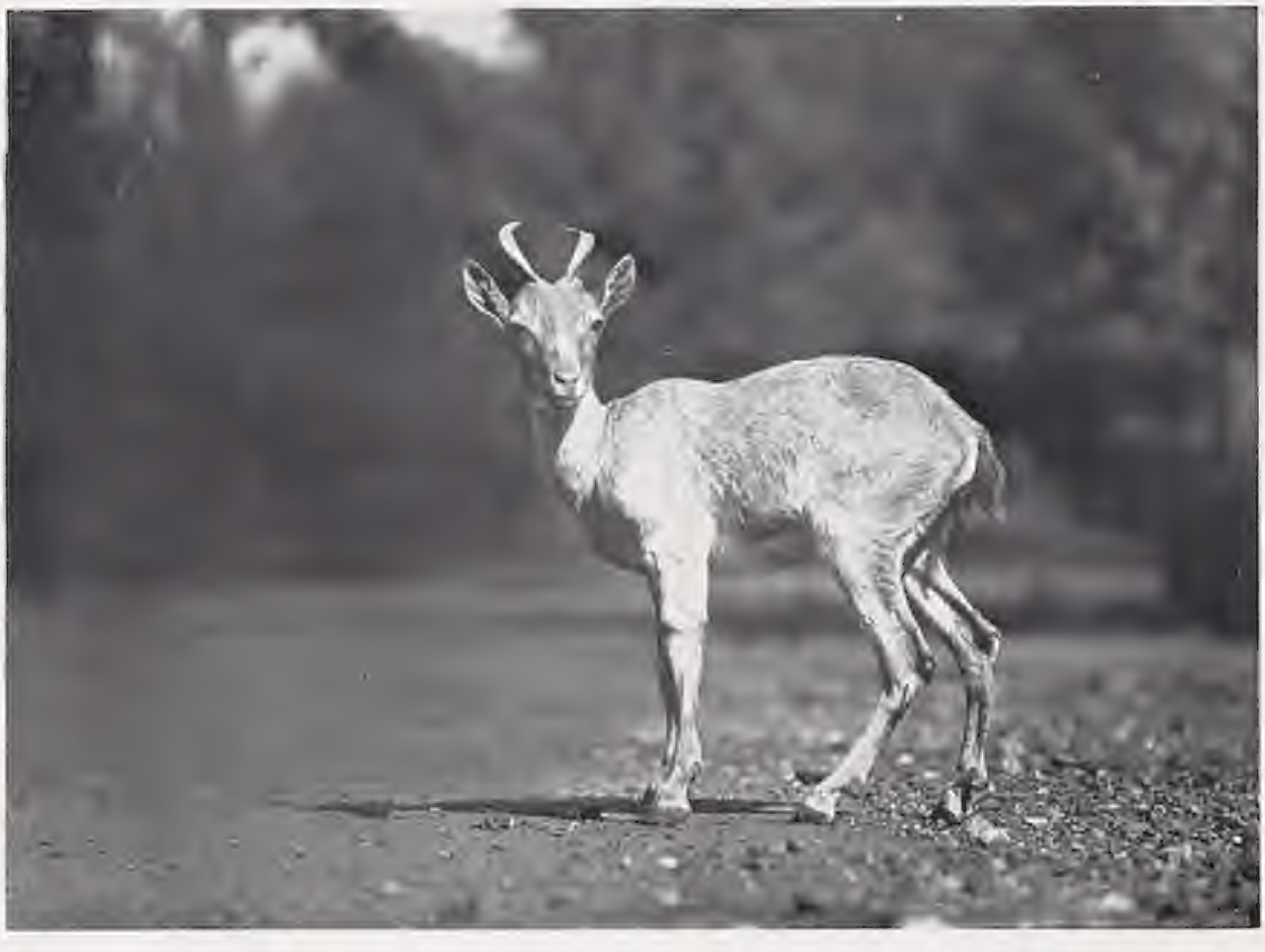
The following list includes the principal sheep, goats and rock antelopes of the world.

Wild Sheep, Goats and Rock Antelopes.

Sheep

Principal species and races.		Habitat.
Ovis aries	Domestic Sheep	The origin of the domestic sheep is lost in antiquity.
Ovis musimon. Apparently two races, in one the ewes are hornless, in the other they have short horns.	Mouflon	Sardinia and Corsica.
Ovis orientalis orientalis	Cyprian Red Sheep	Cyprus.
gmelini	Armenian Red Sheep	Armenia, parts of Asia Minor and Transcaucasia.
erskinei	Persian Red Sheep	Elburg Mts. of Persia.
Ovis vignei vignei	Urial: Ladak Sha	Astor and Ladak.
cycloceros	Afghan Urial	Afghanistan, Baluchistan.
punjabiensis	Punjab Urial	Cis-Indus Punjab.
Ovis ammon ammon	Siberian Argali	Now chiefly in the Altai Mts.
hodgsoni	Tibetan Argali	Plateau of Tibet.
mongolica	Mongolian Argali	Southern Mongolia and the Ta Ch'ing Mts.
littledalei	Littledale's Argali	Central and Eastern Tien Shan.
poli	Marco Polo Argali	The Pamir Plateau.
Ammotragus lervia. Several local races, the typical form from Mauretania.	Aoudad: Barbary Mt. Sheep	Mountains of North Africa.
Pseudoïs nahoor. A race has been described from Shen-si.	Burrhel: Blue Mt. Sheep	Central Asia, Tibet.
Ovis canadensis canadensis. Nine forms have been described. Principal ones are	Bighorn: Rocky Mt. Sheep	Alberta south to New Mexico. E. Washington and Oregon.
texiana	Texas Bighorn	Guadelupe Mts. of Texas and Arizona.
nelsoni	Desert Bighorn	S. Nev., S. Calif. and N. L. Calif.
nivicola	Kamchatkan Bighorn	Kamchatka.
borealis	Siberian Bighorn	Parts of Eastern Siberia.





Above, the Suleman markhor and a young kid of the same species below, the latter now on exhibition at the Zoological Park. Since this photograph was taken, about two years ago, an additional complete turn has been added to the horns.

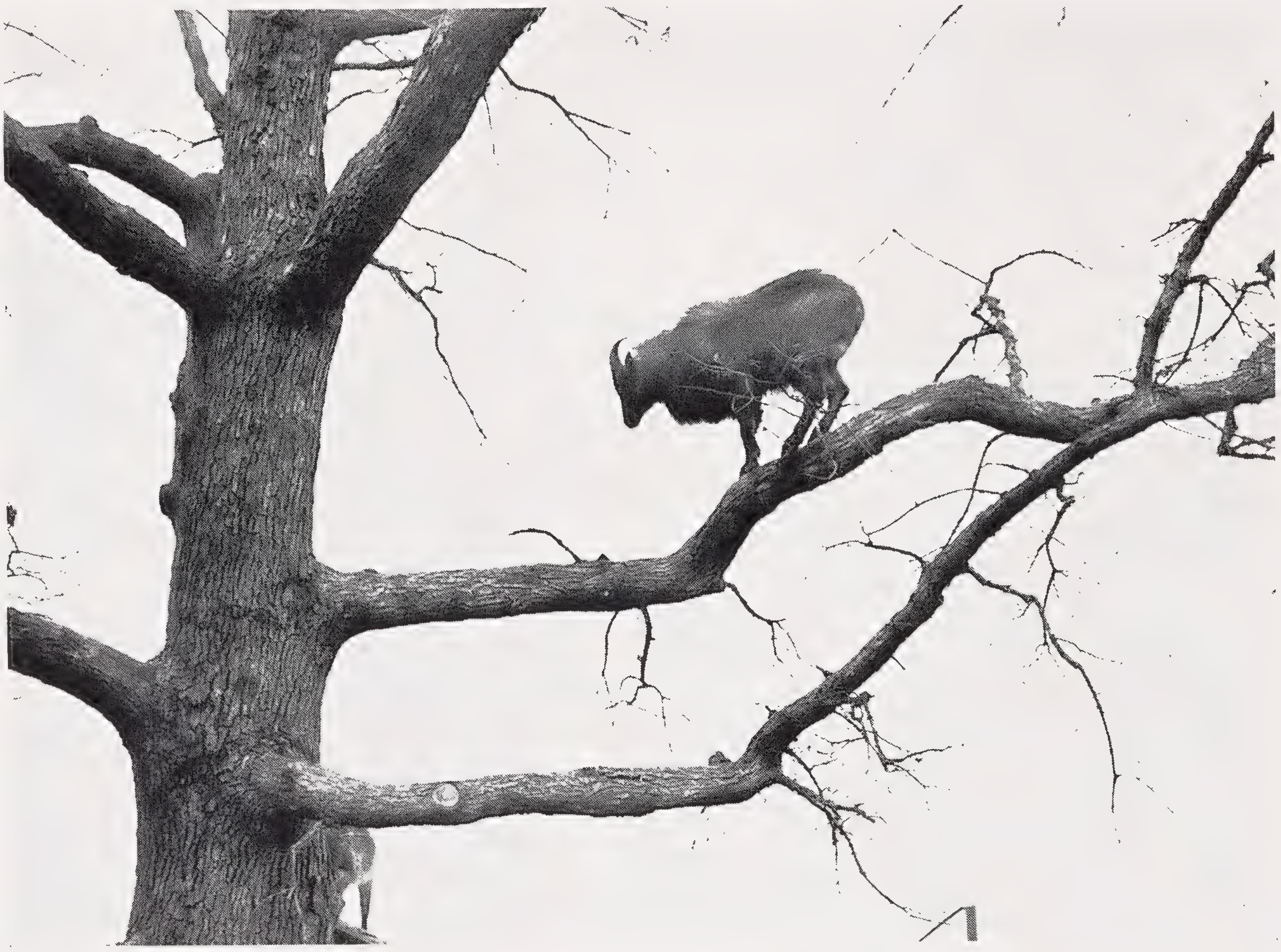
Ovis dalli dalli	White Mt. Sheep	Alaska and Yukon, south-eastward in the Mackenzie Mts.
kenaiensis	Kenai Bighorn	Kenai Peninsula, Alaska.
stonei	Black Mt. Sheep	Northern British Columbia to the Yukon.
fannini	Fannin Mt. Sheep	Yukon.

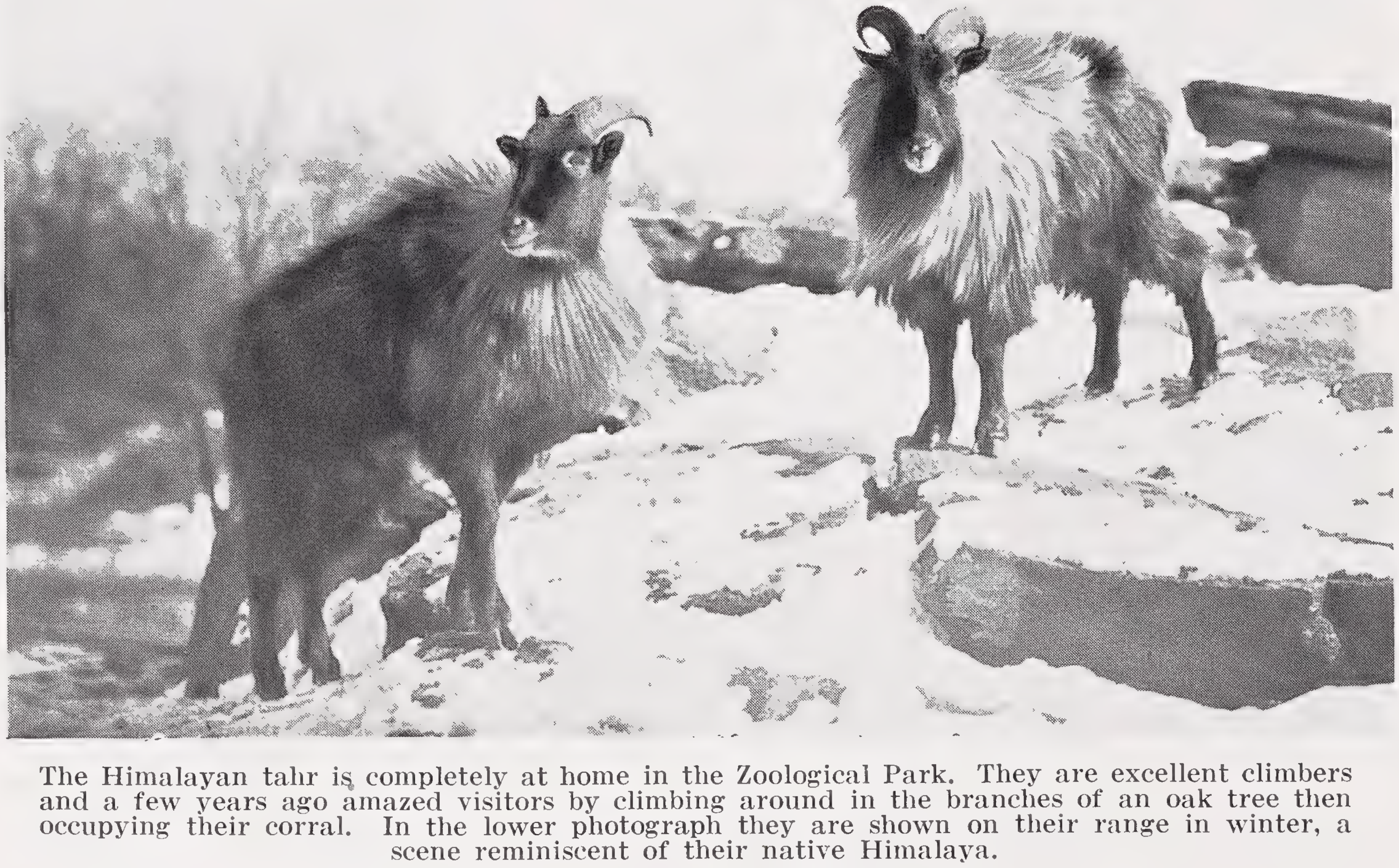
Goats

Capra hircus hircus	Domestic Goat	Feral in many parts of the world.
aegagrus	Persian Wild Goat. Apparently the ancestral form of the domestic goat.	Persia and Caucasus.
Capra severtzowi	West Caucasian Tur	Western Caucasus.
Capra caucasica caucasica	East Caucasian Tur	Eastern Caucasus.
cylindricornis	Pallas' Tur	Eastern Caucasus.
Capra pyrenaica. There are four local races.	Spanish Ibex	Pyrenees, Central Spain, Andalucia and Portugal.
Capra ibex	Alpine Ibex: Steinbok	Now found only in Italian Monte Rosa.
Capra sibirica sibirica. Eight races are recognized.	Asiatic Ibex	Central Asia, N. into Siberia.
altaica	Altai Ibex	Altai Mts.
almaysi	Tien Shan Ibex	Tien Shan Mts.
skyn	Himalayan Ibex	Himalaya.
Capra walie	Abyssinian Ibex	Abyssinia.
Capra nubiana nubiana	Nubian Ibex	Parts of N.E. Africa.
mengesi	Arabian Ibex	Southern Arabia.
sinaitica	Sinaitic Ibex	Sinai.
Capra falconeri falconeri	Astor Markhor	Astor, Baltistan and Chilas.
jerdoni	Suleman Markhor	Suleman Mts., Afghanistan and Baluchistan.
Hemitragus jemlahicus	Himalayan Tahr	Middle Himalayas.
Hemitragus hylocrius	Nilghiri Tahr	Mountains of Southern India.
Hemitragus jayakari	Arabian Tahr	South-eastern Arabia.

Rock Antelopes

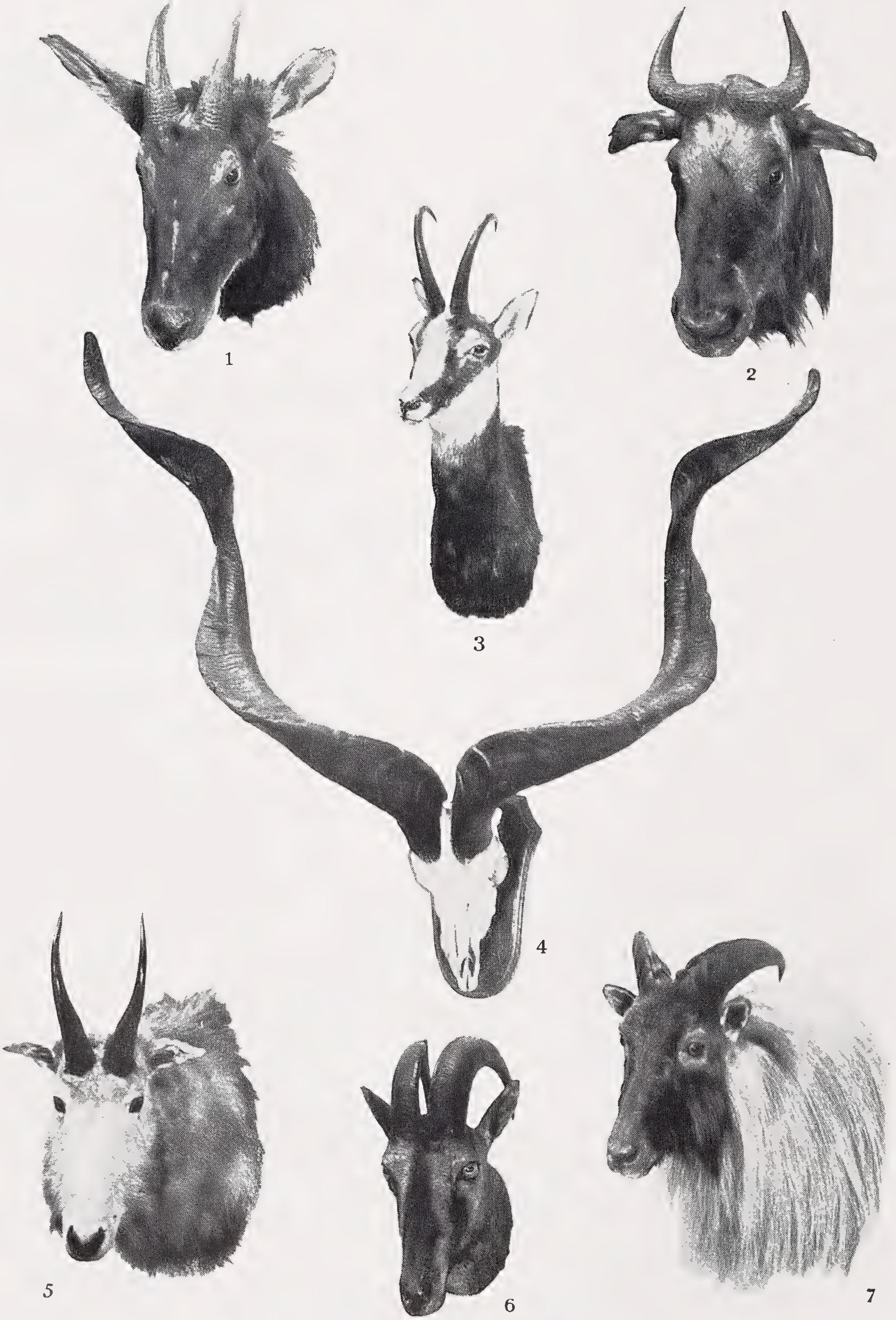
Rupicapra rupicapra tragus	Chamois	Alps.
pyrenaica	Izard	Pyrenees.
parva		Cantabrians.
ornata		Apennines.
caucasica		Caucasus.
asiatica		Trebizond.



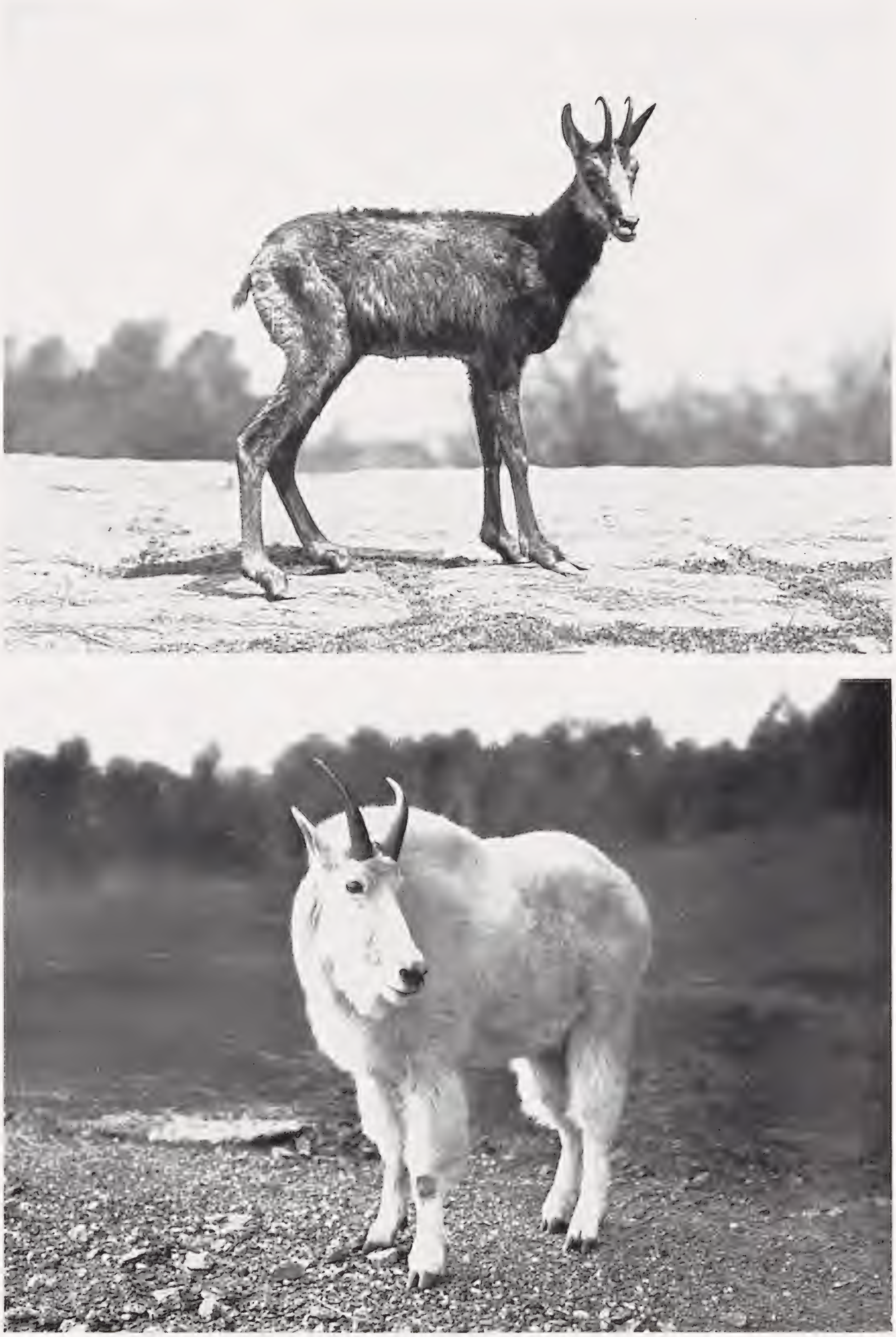


The Himalayan tahr is completely at home in the Zoological Park. They are excellent climbers and a few years ago amazed visitors by climbing around in the branches of an oak tree then occupying their corral. In the lower photograph they are shown on their range in winter, a scene reminiscent of their native Himalaya.

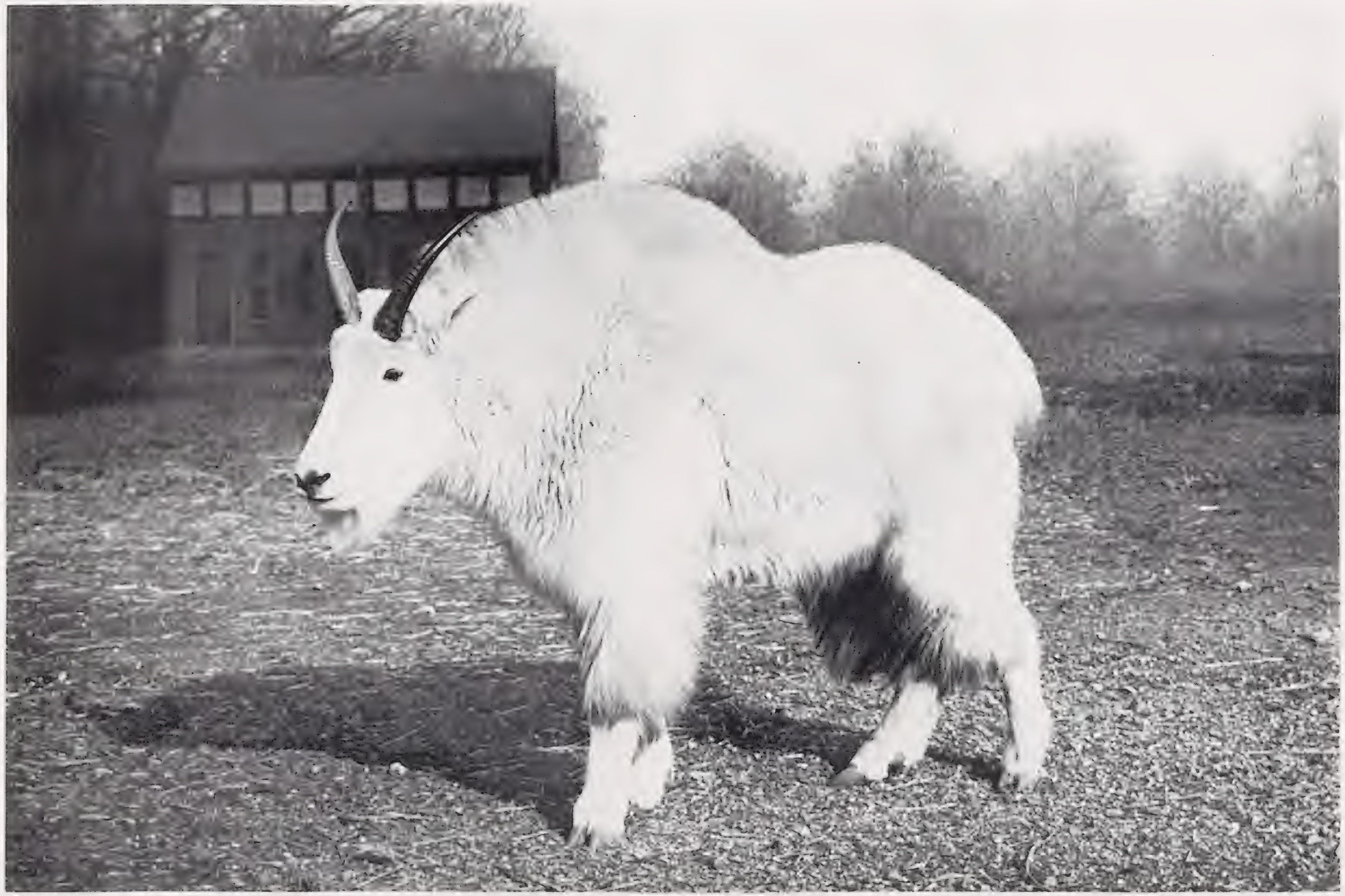
Capricornis sumatraensis. Nine races are recognized.	Serow	Yun-nan. E. Himalayas, Assam, Siam to higher parts of Malay Peninsula, W. Sze-chuan and S.W. Kansu.
s. milne-edwardsi	West China Serow	
Capricornis argyrochoetes	White Maned Serow	S.E. China, Che Kiang Province.
Capricornis crispis	Japanese Serow	Japan.
Capricornis swinhoei	Formosan Serow	Formosa.
Nemorhaedus goral	Gray Himalayan Goral	Western Himalayas.
Nemorhaedus griseus	Sze-chuan Goral	Sze-chuan and Upper Burma.
Nemorhaedus hodgsoni	Brown Himalayan Goral	Eastern Himalaya.
Nemorhaedus caudatus	Long-tailed Goral	Sze-chuan.
Nemorhaedus raddeanus	Korean Goral	Korea.
Budorcas taxicolor taxicolor	Takin	Northern Assam.
whitei	White's Takin	Bhutan.
Budorcas tibetanus	Sze-chuan Takin	Sze-chuan Yun-nan, Tibet.
Budorcas bedfordi	Golden Takin	S. W. Shen-si.
Oreamnos americanus americanus	Rocky Mt. Goat	Cascade Mts. of Washington.
columbae		Northern British Columbia.
missoulae		Montana and Idaho.
kennedyi		Mouth of Copper River, Alaska.



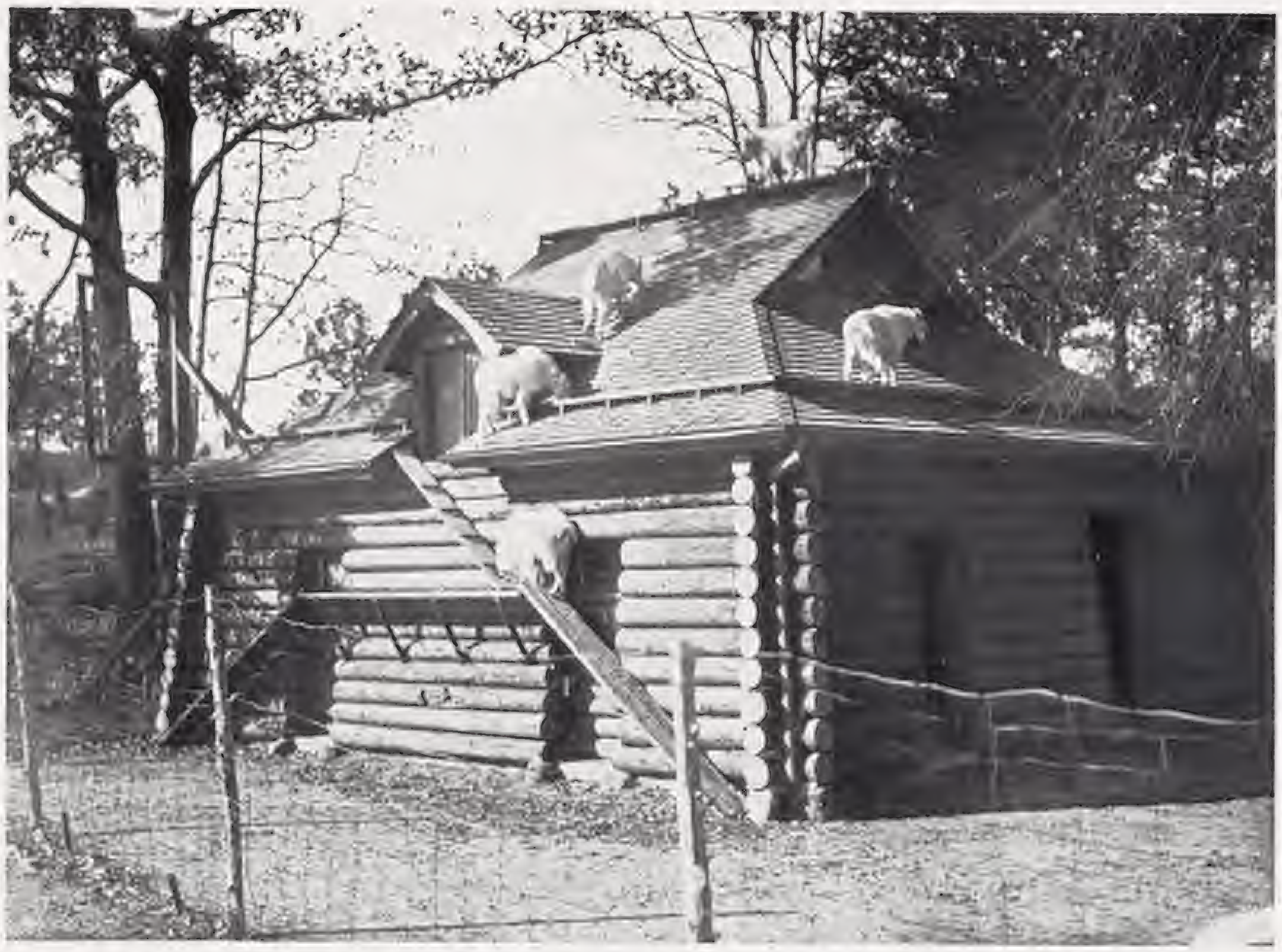
A group of rock antelopes and aberrant goats. (1) serow, (2) Chinese takin, (3) chamois, (4) Astor markhor, (5) Rocky Mountain goat, (6) Nilghiri tahr, (7) Himalayan tahr. From the National Collection of Heads and Horns.

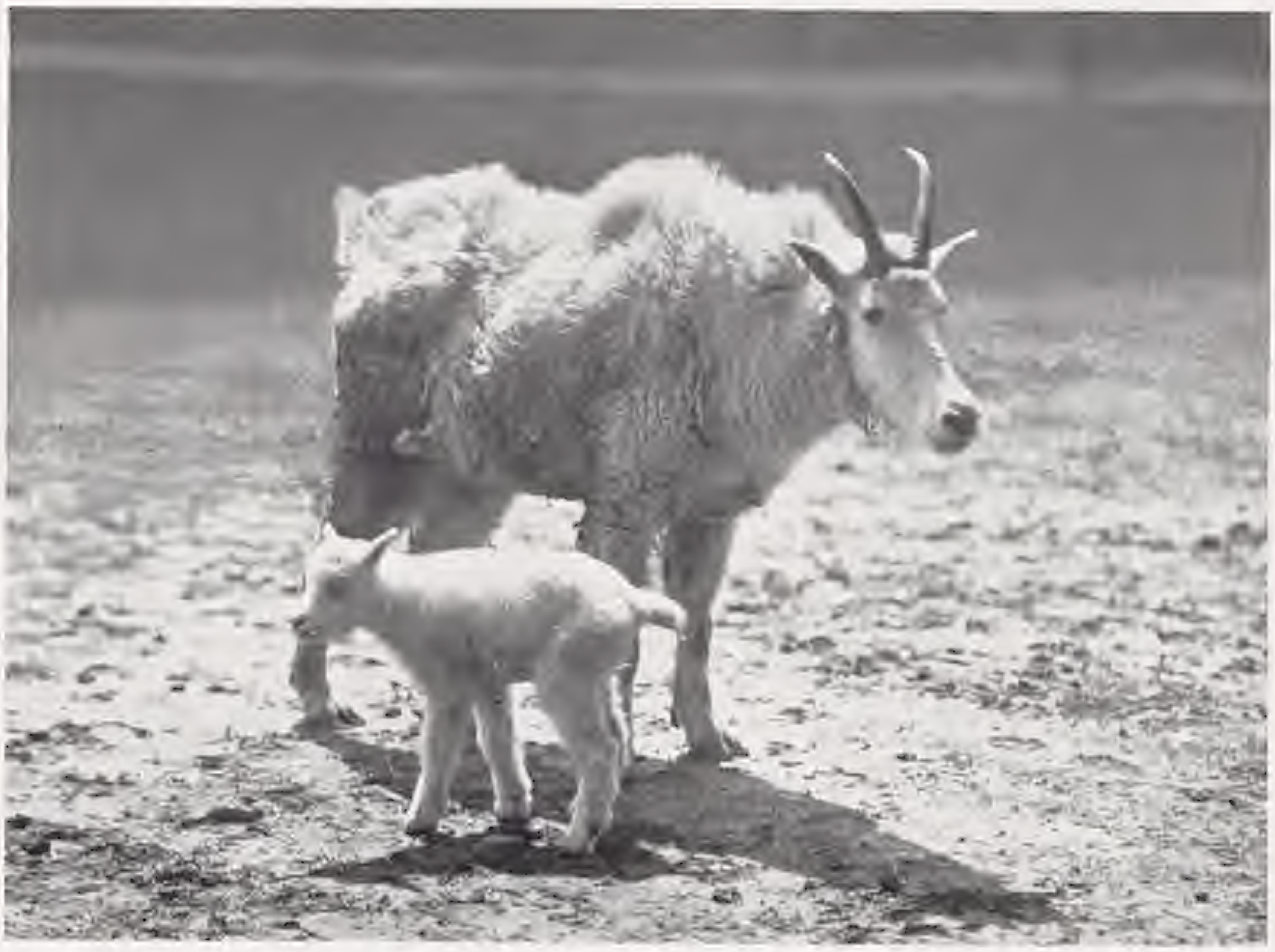


Two well-known representatives of the Rupicaprinae, the Chamois above, and the Rocky Mountain Goat below. These animals show the great divergence in form and color exhibited by the members of this group.

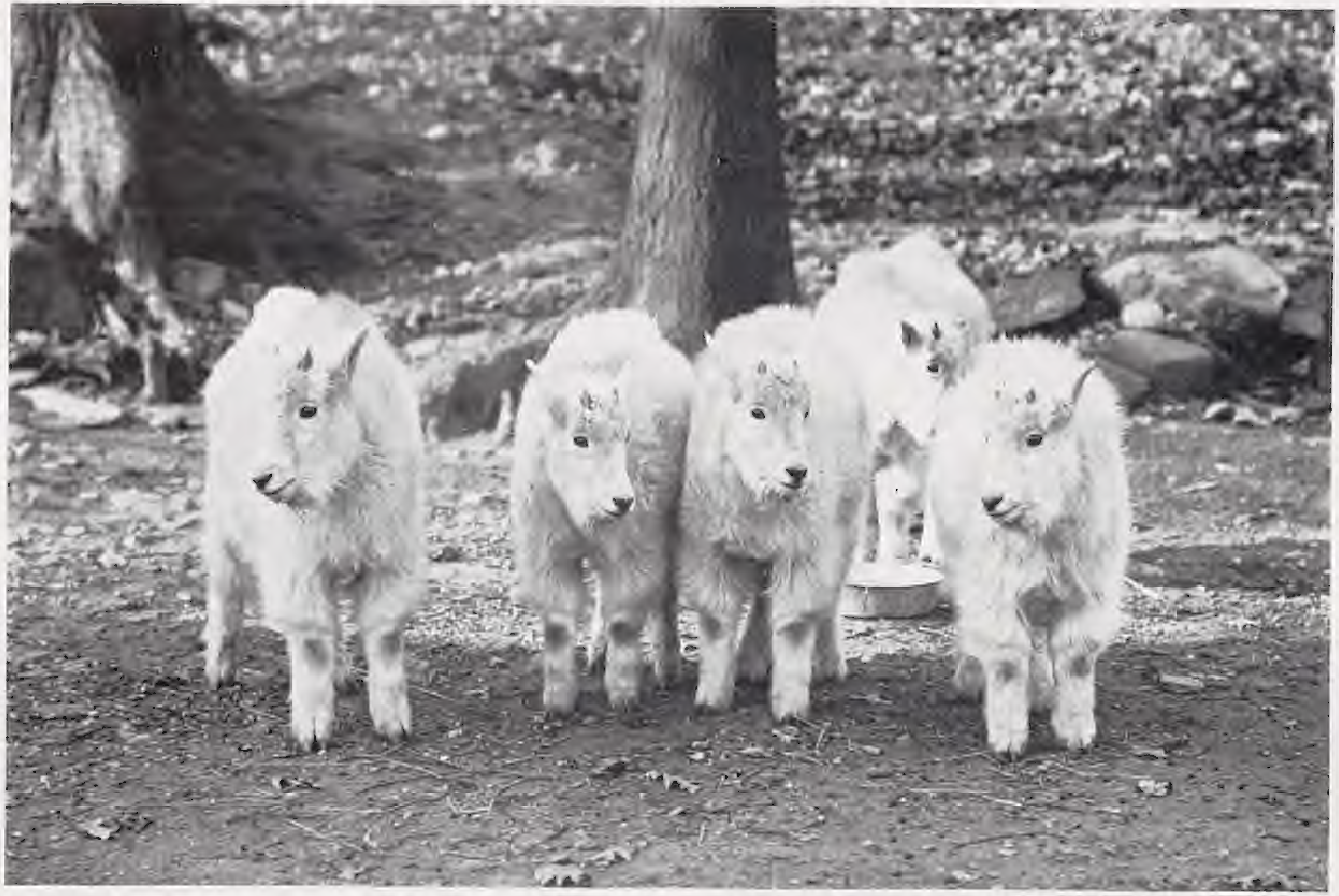


A magnificent specimen of the Rocky Mountain goat formerly exhibited at the Zoological Park. It is unfortunate that these fine animals do not thrive for long in the climate of New York City. Our present specimen, a female, is an exception, now in her ninth year at the Park.





The inclined runways reaching to the roof of the shelter house in the upper photograph were used by the young mountain goats to climb to the top of the structure where they presented an interesting sight to our visitors. Below, a Mountain goat and her young kid born in the Zoological Park.



This interesting quintet of young Mountain goats was secured in British Columbia and afterward exhibited in the Zoological Park. It is needless to say that they evoked an extraordinary amount of public interest.

The London Conference for the Protection of African Fauna and Flora

October 31-November 8, 1933

J. C. Phillips

THERE are many Americans who look back on their travels, hunts or collecting trips in Africa as the brightest interlude in an otherwise rather ordinary sequence of experiences. To these men and the many thousands of others who consume the Sunday supplement pictures of Africa and sit through animal films with a kind of vicarious shiver, it will be good news to hear that very definite progress has recently been made in the better protection of vanishing African wild life.

There has recently been held in London the second international conference on the preservation of the fauna and flora of Africa. All parts of that great continent, now fast losing its primitive characteristics, were represented and at the conclusion of the conference all delegates from the interested powers signed a well-thought-out draft convention. Lord Onslow, president of the Fauna Society, was elected president of the conference, and Baron de Cartier de Marchienne, the Belgian Ambassador, its vice-president. Mr. Francis Hemming, joint secretary of the Economic Advisory Council, was secretary-general for the conference.

The British were of course well represented with five delegates and many official advisers. Egypt, Southern Rhodesia and the Anglo-Egyptian Sudan had representation while the Union of South Africa had an able spokesman in Hon. C. te Water, High Commissioner for the Union in London. The Belgians had a delegation of five headed by that veteran diplomat, Baron Cartier, formerly at Washington but now Ambassador at the Court of St. James. One of the best informed of all delegates was Dr. Van Straelen, director of the Brussels Museum, who had much of importance to contribute.

The Italian delegation, with Dr. Tullio Zedda as its principal spokesman, was prominent in most of the discussions, while the Portuguese sent only two delegates, one of whom was Dr. Ulrich, Ambassador at London. France sent six delegates at first headed by Dr. Gruvel of the Committee for the Protection of the Fauna and Flora of the Colonies, and later by M. Ruffat, director of the Bureau de la Chasse in the Colonial Ministry. Spain sent two delegates; Don Ramon Perez de Ayala, the Ambassador to England, and Don José da Casa Calzada, agricultural attaché at the Spanish Embassy.

This conference was most fortunate in the choice of its chairman, who acquitted himself well in a situation which might at times have been very difficult but which never reached that point. There was a general feeling of good fellowship and the delegates were made to feel the importance of their mission through a well-arranged series of luncheons, receptions and excursions. The writer had the honor to represent the United States as an Observer selected by our State Department. There were observers also from Holland and from the government of India. Dr. Van Tienhoven of Holland, although only an observer, took a very active part through his position as president of the Administrative Commission of the Brussels office for International Nature Protection, and as usual was able to impress his hearers on several most important points.

The first conference on African fauna was held in London in 1900, and although it was good as a first step it did not have far-reaching results because it was not ratified outside Great Britain. It did result in a cerain amount of education among the powers which up to that time had shown little sense of responsibility, but only in British territories were real reforms begun. The period 1900 to 1933 saw a great increase in game reserves, in protection of rare species, in more efficient warden service, and in the establishment of game departments which more than paid for themselves from the revenue derived from the sale of sportsmens' licenses. East Africa made much more progress than the West African colonies such as Nigeria and the Gold Coast.

It would take far too long to enumerate all the accomplishments of the present convention, nor is this necessary, for much of the time was occupied with the machinery of the treaty act and the difficulty of harmonizing somewhat vague terms in two languages, — French and English.

We in America who are working for the preservation of foreign game animals through our American Committee for International Wild Life Protection, are much pleased to see included provisions for confiscating animals alive or dead (or the parts thereof) where they have been taken illegally in another or neighboring colony. This valuable provision in the treaty is aimed at the illegal traffic in various animal products but especially ivory and rhino horn. Not many people know that Asiatic rhino horn, because of its use in a certain Chinese medicine, is now nearly worth its weight in gold (as high as £18 per pound, and £150 has been paid for a single horn). Fortunately African rhino horn, for some reason unknown to us, is worth less in the Calcutta market. But even so, it now brings double the price of ivory.

Looking ahead twenty-five or fifty years it seems certain that very little animal life of the larger sort will survive in anything approaching its former abundance in Africa outside of parks and reserves. The realization of this rather sad fact has led to an agreement among the participating powers to provide at least four different kinds of nature reserves within their respective territories and to begin the survey of such areas within a short time of the ratification of the convention. Such areas are described in the paper somewhat as follows: (1) "national parks," used in the American sense as areas set aside for public use and enjoyment; (2) "strict natural reserves," areas not open to the public and primarily for the preservation of a "primitive area" as such; (3) "ordinary reserves" for the protection of all game found within them but not on the permanent status of a national park; (4) "special reserves" for the protection of certain rare species of animals or plants found therein.

Attached to the convention is a long list of species which are recommended for special protection under article 8 and these are divided into two Classes, A and B, according to the strictness of the protection considered necessary. Among the more familiar animals in Class A are the following: gorilla, Madagascar lemur, giant sable antelope, nyala, mountain nyala or giant bush-buck, okapi, Barbary stag, pigmy hippopotamus, mountain zebra, wild ass, white rhinoceros, bubal hartebeest (probably extinct), Abyssinian ibex, elephant (when tusks are less than 5 kilograms each), water chevrotain.

In Class B is placed a group of animals which, although not to be subjected to hunting under an ordinary license, may be taken under special license limited as regards the period and area for taking them. Some of the more familiar of these are: chimpanzee, Derby eland, giraffe, white-tailed gnu, bontebok, black rhinoceros and elephant (when tusks are over 5 kilos each).

Our American Committee have for some years urged that a kind of international blacklist be prepared of all those persons who, by their unsportsmanlike behavior while in Africa have given cause for unfavorable comment. Such a list is now provided for and it is hoped that Americans will be conspicuous by their absence from its rolls!

Special attention should be called to article 17 which provides for governments not having possessions in Africa to accede to the principles of the convention either wholly or in part. In the "final act" the hope is expressed that the governments who sent observers (Netherlands, India, United States) will at some future time decide to adhere to the present convention.

This convention comes into force three months after ratification by at least four of the contracting governments. It ceases to exist when, by a series of denunciations, less than four governments adhere to the convention as signed. However, no denunciations can take effect until five years from the time the convention comes into force.

Let us hope that nothing will interfere to delay the bringing into operation of this treaty which marks the first serious attempt to preserve for all time (albeit only in a few favored areas) those remarkable African mammals and birds which have been so greatly depleted in the past 25 years. And it should be understood that only a small part of this reduction of game has been due to the visiting sportsman. The opening up of great regions to white settlement, which always results in game extirpation, the use of guns in the hands of natives who never before had deadly weapons, the control of certain areas in the attempt to limit the spread of tsetse fly-borne diseases, the penetration of good roads into the wilderness of yesterday; these and a score of other happenings underly the disappearance of African game.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-six volumes completed. Volume XXXVII in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
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Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Present Day Mammals (Leister); 74 pp. 105 ills.
Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
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The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
Sea Shore Life (Mayer). *Out of print.*
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend). *Out of print.*
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For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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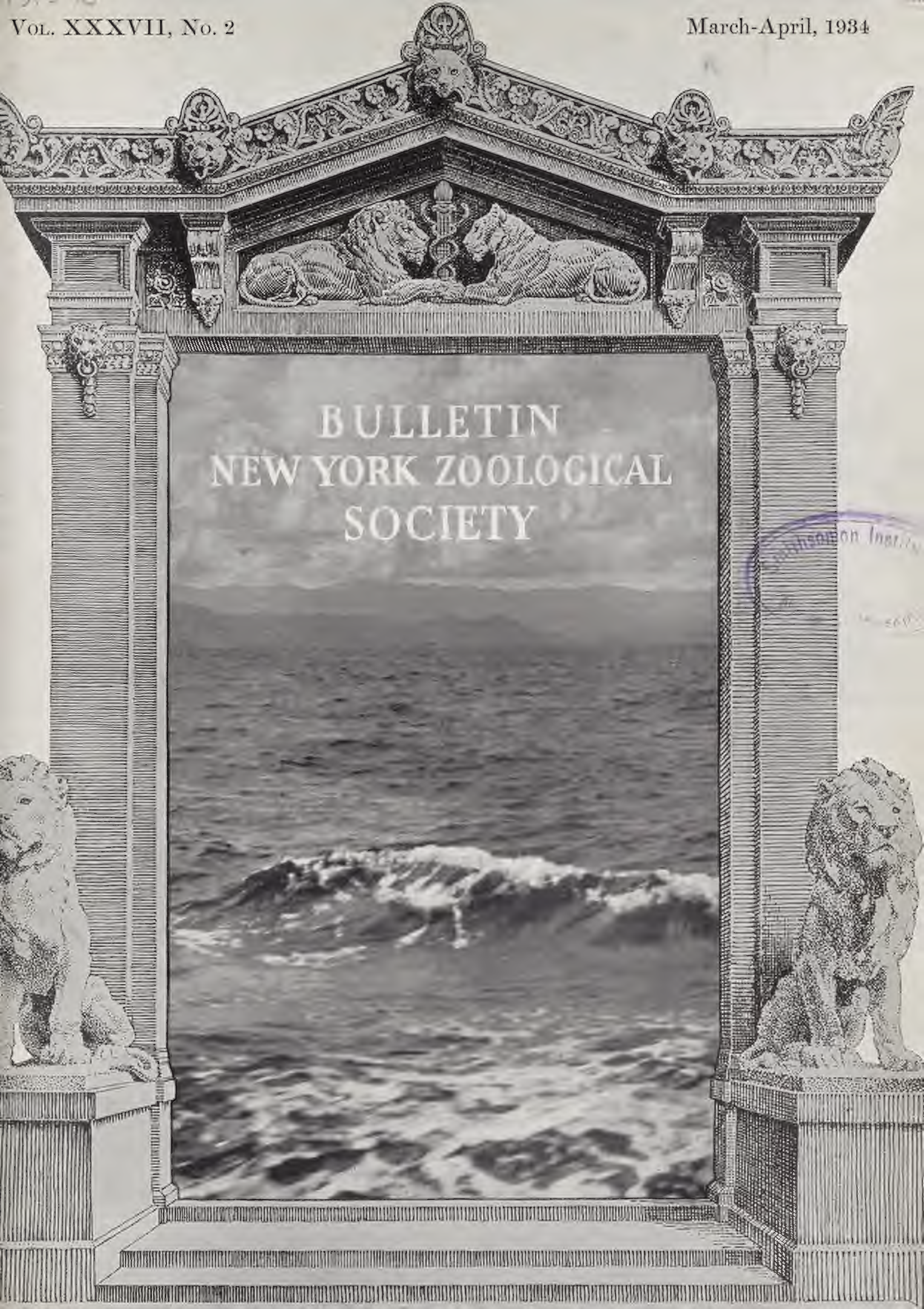

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BULLETIN

New York Zoological Society

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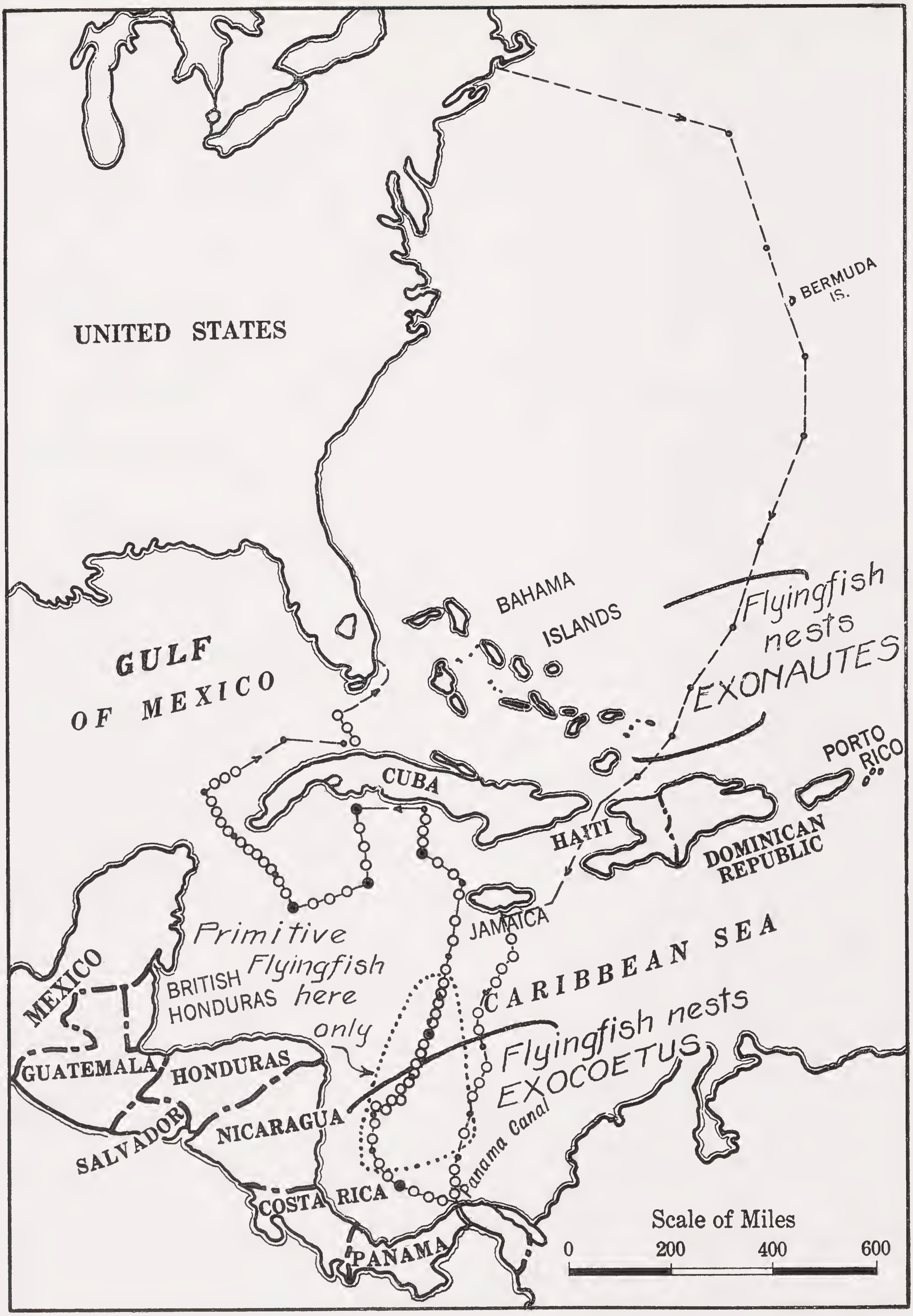

A sketch chart of the 1934 Caribbean *Atlantis* cruise, with notes on flyingfishes. The daily mean positions are indicated by black dots from January 21 to March 4. The hydrographic stations are indicated by small circles from No. 1935 to No. 2008. The area marked between Bermuda and Haiti shows the region in which the eggs and nests of the four-winged flyingfish, *Exonautes,* were found. The area marked north of Panama shows the region in which the eggs and nests of the two-winged flyingfish, *Exocoetus,* were found. The elliptical area in the same region represents the locality in which the primitive flyingfish *Oxyporhamphus* was found, a form new to the Caribbean.

BULLETIN
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The Oceanographic Vessel *Atlantis* in the West Indies

An Account of the Second Joint West Indian Expedition, Sponsored by the Bingham Oceanographic Laboratory and the Woods Hole Oceanographic Institution

C. M. Breder, Jr.

PURSUANT to an extensive survey of the biological conditions represented in the much discussed but still poorly understood Sargasso Sea, the auxiliary ketch *Atlantis* recently cruised through various West Indian waters in search of critical data. The curator of the Bingham Oceanographic Collection and Laboratory, Yale University, Prof. A. E. Parr, led the expedition—the third which he has managed in his present intensive study of the Central American seas, and the second to which the Woods Hole Oceanographic Institution has lent its cooperation and the facilities of its excellent research ship.

Although many naturalists have visited regions in which sargasso weed occurs, there has previously been no attempt to work out the problems in a detailed quantitative manner. While an accompanying article by Professor Parr explains his problem and program, it may be pointed out here that it entails the consideration of many diverse fields, both biological and physical. The various organisms associated with sargasso weed, and their ecological relationships, are all embraced by the program. The writer's scientific connection with all this is conditioned to a considerable extent by his long standing interest in flying fishes, certain of which enter into the sargasso weed complexities, while the holding of a research associateship with the Bingham Laboratory facilitated arrangements. Incidentally, it is of considerable sentimental satisfaction to him that the first Bulletin of the Bingham Laboratory was prepared under his hand in 1927. Since then, thanks entirely to the indefatigable and intelligent efforts of Professor Parr, the organization has grown in importance until now its publications, collections and program have attained acclaim wherever oceanographers and ichthyologists foregather.

The interests represented by the scientific party on the cruise give a fair idea of the diversity of subjects that require special attention in order to work out the sargasso weed problem in a properly scientific manner. In addition to Prof. Parr the party consisted of Dr. A. Forbes, Harvard University and Trustee of the Woods Hole Oceanographic Institution, neurology; T. S. Greenwood, Woods Hole Oceanographic Institution, hydrography; M. D. Burkenroad, Bingham Laboratory, carcinology and sargasso epizoa; M. Bishop, Peabody Museum of Natural History, Department Zoology, collection and preparation; H. Sears, Woods Hole Oceanographic Institution, ichthyology.

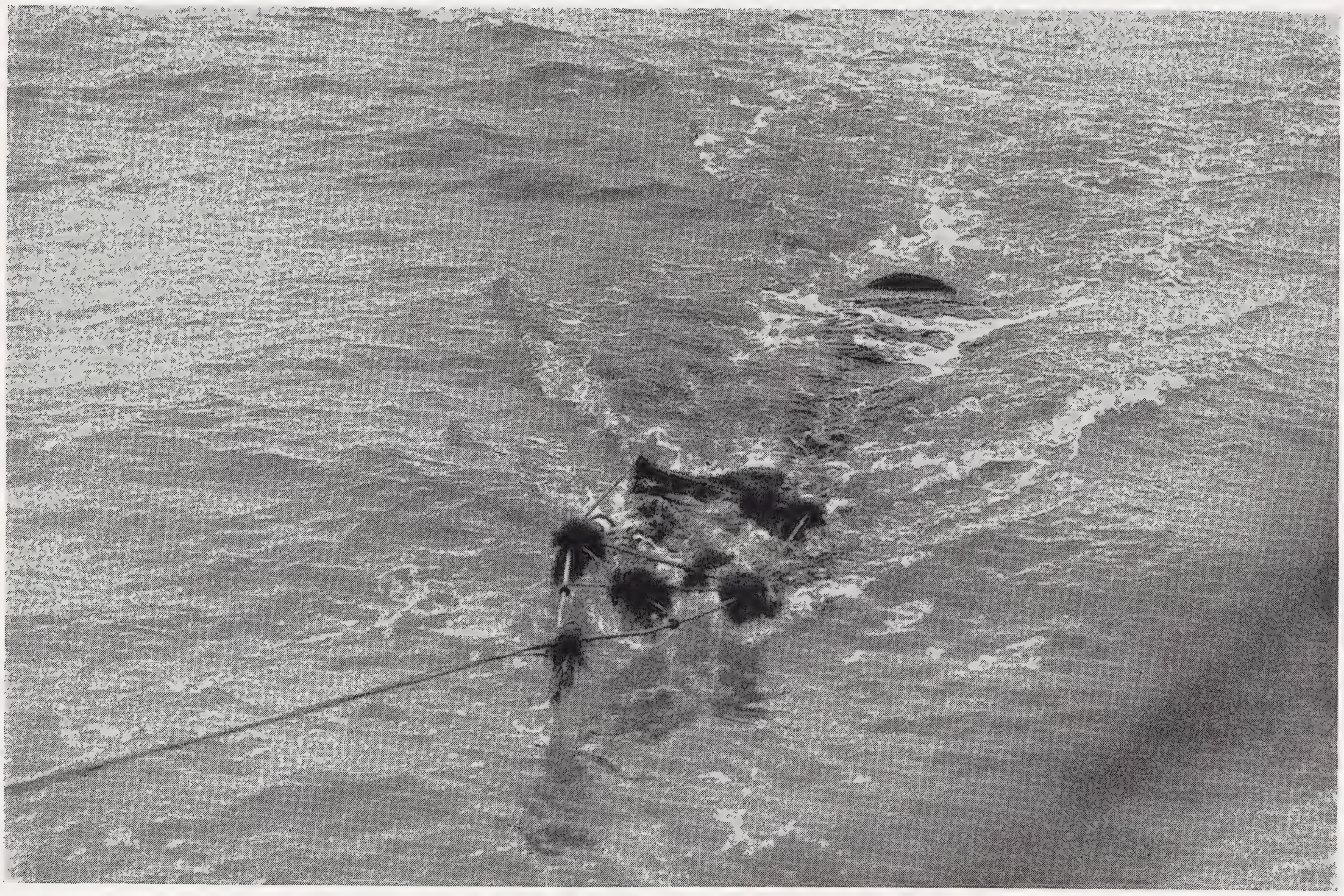
The cruise covered about 5,000 miles with but four ports of call: Kingston, Jamaica; Colon, Panama; Miami, Florida and New York City. Most of the time was spent on the open ocean, well out of sight of any land. The general itinerary was as follows: Woods Hole, Mass., to off the Bermudas to Turk's Island, through Turk's Island Pass and Windward Passage to port at Kingston, Jamaica; to port at Colon, Panama; along the Mosquito Bank off Nicaragua, to off the north coast of Jamaica, to off the

A clump of sargasso weed bound together by the white threads of a flyingfish nest. These lines are most evident near the upper part of the picture, and more or less radiate from the band.

south coast of Cuba, to Bartlett Deep, to off the Isle of Pines, to Yucatan Channel, to off Key West, Florida, to off Havana, Cuba, to port at Miami, Florida; to port at New York City; to Woods Hole. The accompanying chart gives a better idea of the actual course. The writer's efforts on the trip were directed to the following ends: To obtain further data and specimens of flying fish, especially in connection with their relation to sargasso weed; to obtain data on open ocean conditions looking toward improvements at his home institution, the New York Aquarium, and to obtain such living specimens as might be useful to the collection of the latter place.

The collection and study of the ever fascinating flying fishes was pursued primarily by two methods, chiefly observation by day but actual collection by night. Every sea voyager, who has traveled in any of the tropical waters of the world, has probably seen these piscine aviators and at least speculated on the mechanism of their flight. These fishes display their soaring prowess wherever the water is warm—in a band girdling the world at the equator, and extending north and south of it to an irregular boundary on either side, extended or contracted in accordance with the influential ocean currents of differing temperatures. Considering the daylight activities first, one of the studies involved the statistical observation of the numbers of fishes flying in different localities and under varying atmospheric and wave conditions. In all exactly forty-four hours, in half hour periods, were so passed. It is undeniable that this sort of work becomes tedious after the first few days, especially when it has been engaged in on previous sea trips, to say nothing of the eye strain involved. Consequently it was with much gratitude that I accepted the offer of both Dr. Forbes, Mr. Sears and Mr. Burkenroad to relieve me at times. While it is not the proper time or place to discuss the data so obtained, as it requires analysis and statistical study, it may be mentioned that the largest number of fliers counted in a single period (one-half hour) was one hundred and thirty. This was off Cape San Antonia, Cuba. The longest timed flight amounted to not quite twenty seconds, during which time a surprising distance can be covered. However, much longer flights are sometimes to be observed. The above facts are mentioned merely to give the reader some idea of the extent of this kind of fish activity existent in the West Indies.

The actual collection of specimens took place mostly at night. Flying fishes on the high seas are notoriously difficult to obtain in any quantities for scientific studies as the more ordinary methods of fish-catching do not work out very well with these exceedingly mobile creatures. At each hydrographic station made after dark, a waterproof electric light was dropped a foot or so below the surface. The effect of such a light on various kinds of fishes is not unlike that of a lamp on insects. As they come swimming about the light it is a relatively easy matter to dip them out of the sea with a long handled hand net. The flying fishes are apt to swim slowly in toward the light, usually with their "wings" spread out to their full extent. At such times



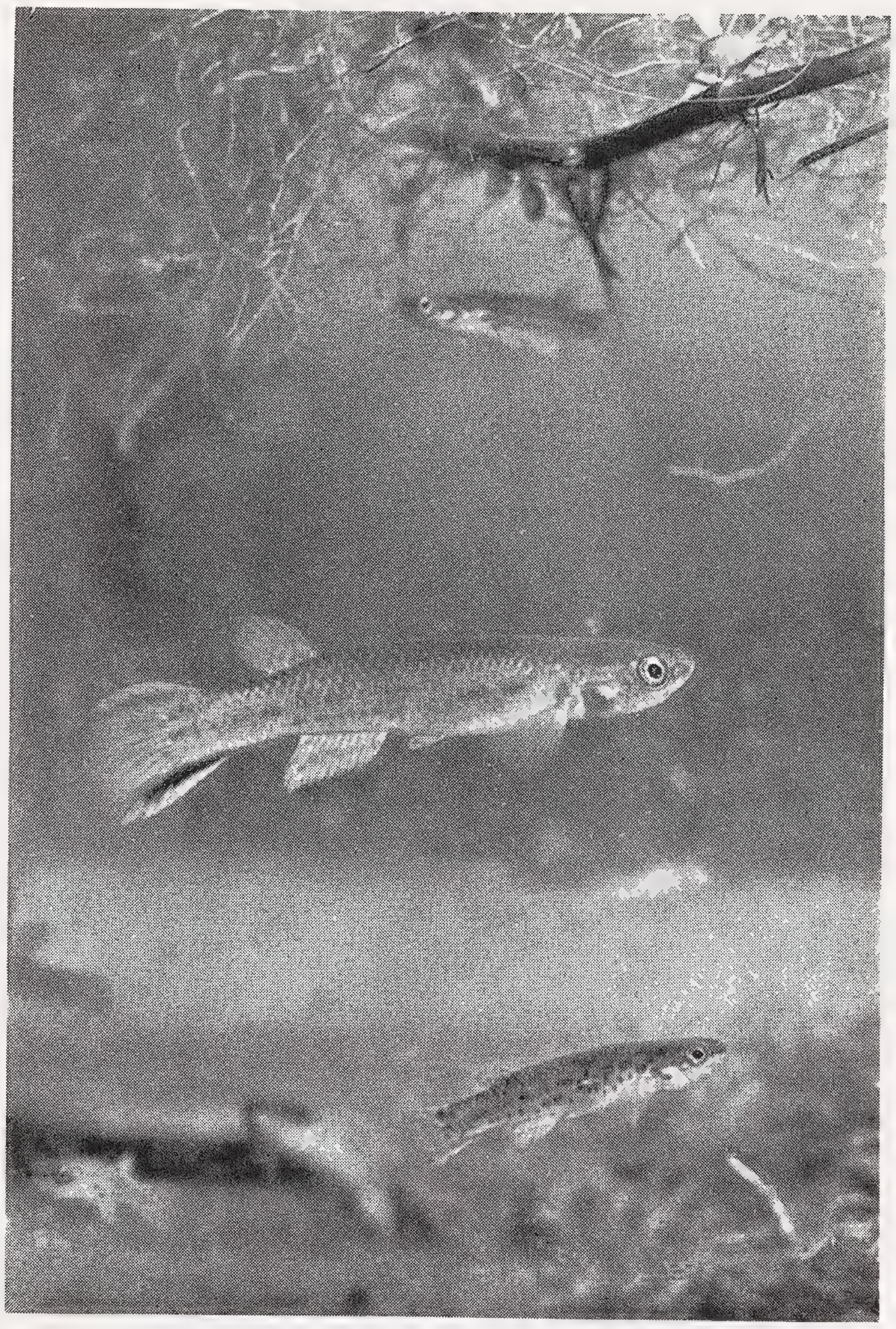
The tow-net used for collecting extensive samples of sargasso weed. This net was practically in continuous operation. A quantitative measure of the weed's abundance was obtained by weighing the amount taken over a given distance.

Professor A. E. Parr and Harry Sears sorting a load of sargasso weed just brought on board by the tow-net. Numerous interesting invertebrates are frequently encountered, and now and then a flyingfish nest.

In addition to the tow-net, numerous interesting specimens were collected by dip-net.

they "loaf" about in a resting position but are off in a flash, either above or below the surface, on any false move on the part of the netter. At these times the exceedingly active and unbelievably fast pelagic squids also come about the light and prey on such fishes as may be there. On various occasions such squids took exceptionally choice specimens from under our very noses, because they are simply more skillful and more experienced at catching flying fishes. There is a distinct fascination to this method of collecting and practically everyone, crew and scientific staff, took a try at the overboard light method. Mr. Bishop and Chief Engineer Backus were especially intrigued, and I have them to thank for many choice specimens. While there is nothing new about the use of the overboard light, previously most such collecting has been done in harbors, or anchored close to shore. No extensive collecting of the kind has been done in the West Indies with the vessel simply hove-to in the open sea. This probably accounts for the surprising amount of material obtained of rare and little-known forms—species that probably lead a life entirely away from even insular shores. A study of this material is now under way, but it would be premature to attempt a discussion of its biological significance at this time. One of the more interesting items, however, may be mentioned in passing.

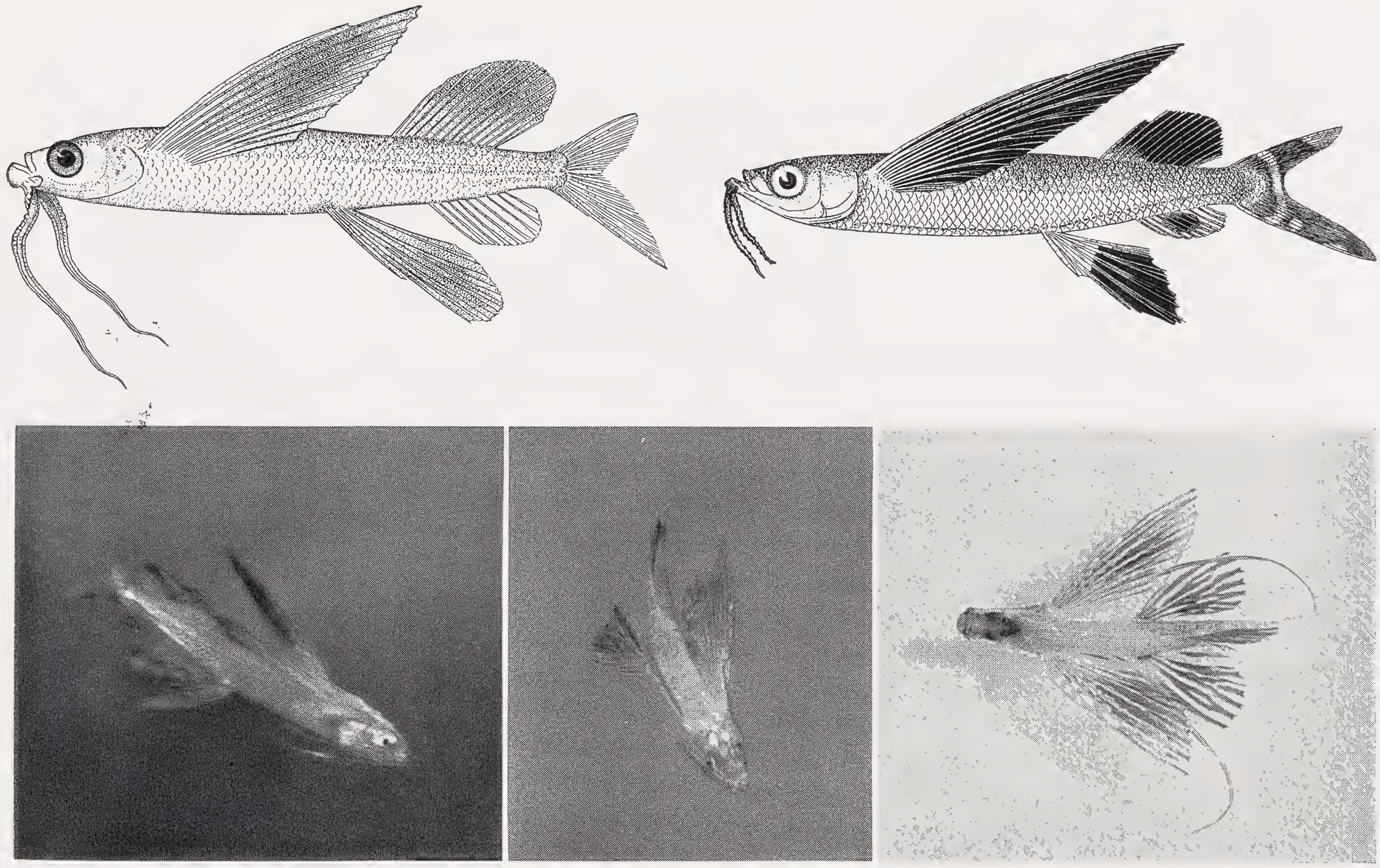
There lives in the Pacific Ocean a primitive flying fish with very short wings that is incapable of any protracted flight. This fish, *Oxporhamphus* (*Evolantia*) *micropterus*, has been considered close to the ancestral line of the worldwide two-winged or monoplane flying fish, *Exocoetus* (*Halocypselus*). On the other side it shows unmistakable relationship to the halfbeaks, prominently in that the young possess the elongate lower jaw of that group. Nothing of the sort had ever been taken in the West Indies before, but we found that in the region southwest of Jamaica, but well offshore, this fish or a species scarcely differentiable from it is fairly common. In fact a developmental series was obtained that shows the loss of the juvenile beak and includes specimens fully adult. It is difficult to understand why at least some material had not been taken by earlier parties.



These fishes, taken in a small stream on Barro Colorado Island, are here seen at home in the New York Aquarium. This species, *Rivulus brunneus* Meek and Hildebrand, were formerly known only from the type locality, another Panama stream not on the island. This is the first photograph of the species that we know of, and they are apparently the first to be brought back alive. The younger fish are covered with deep red dots that fade as size increases, while a party-colored bar on the tail becomes more prominent. Photo by S. C. Dunton.

Two striking specimens of fish, described some years ago as *Cypselurus monroei* by Mr. J. T. Nichols and the writer, were caught which represent a remarkable stage in development not seen before. This species is characterized by two long barbels on the chin. In the two obtained on this expedition, the barbels actually reach a considerable distance beyond the tip of the tail! It is difficult to imagine any important value that such trailers might have to a flying fish, especially as they are living side by side with numerous other species that survive satisfactorily with no barbels at any stage. There is also a single specimen of the fish that Dr. Beebe described from east of Puerto Rico as *Cypselurus antarei*, this flying fish having a single chin barbel.

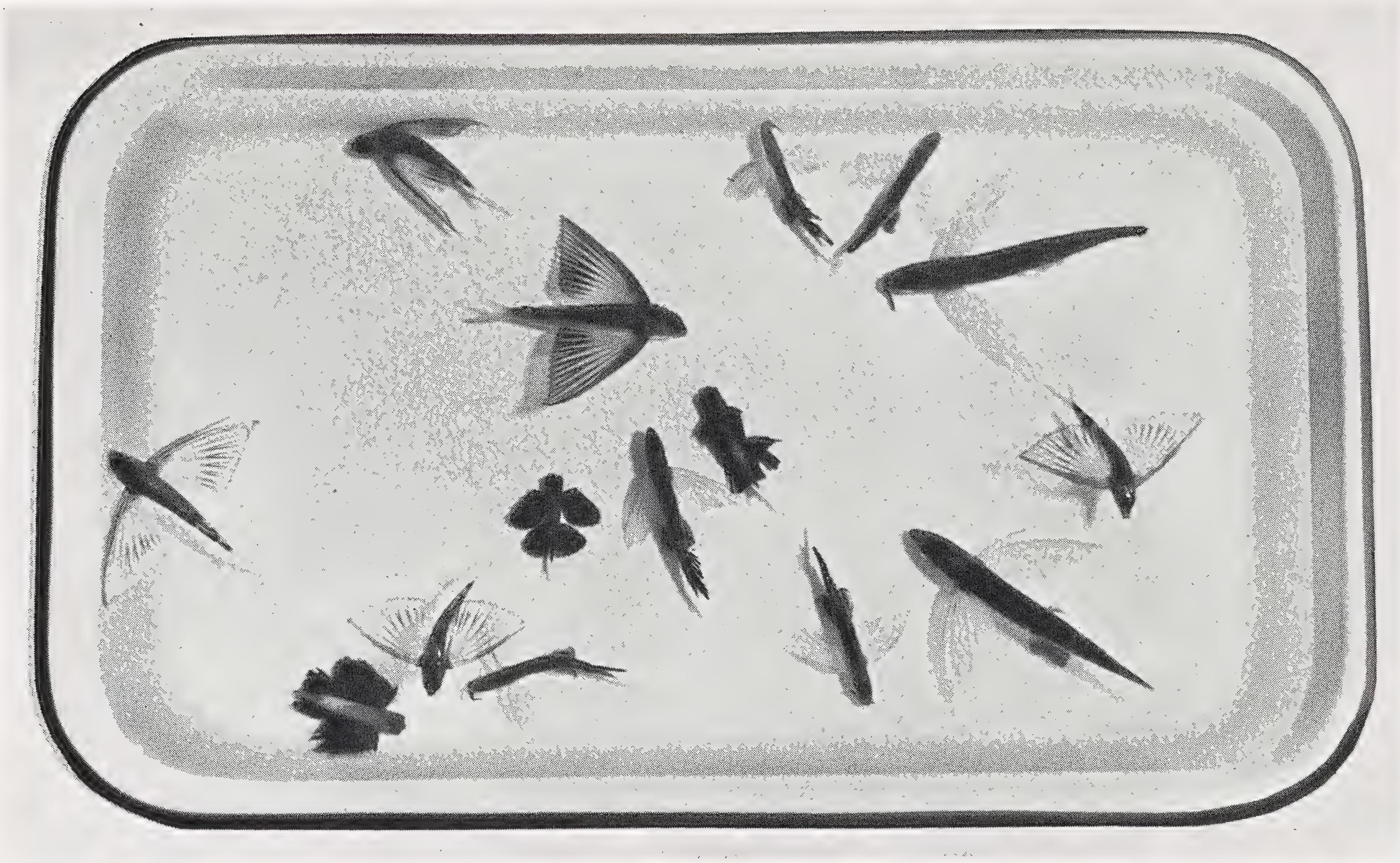
A tame Panama deer comes to the laboratory door just before sundown, in the expectation of being fed, at the Barro Colorado Research Station.



The long-barbeled flyingfish *Cypselurus monroei* Nichols and Breder. The upper left drawing represents the type specimen, a fish of only 48 mm. from the Florida Keys. (Drawn by Louise Nash.) The upper right drawing represents an adult of 151 mm. from off the Dry Tortugas. (Drawn by Jean Roddan.) The lower photographs represent three postures of an intermediate size (58 mm.) taken on the *Atlantis* expedition between Jamaica and Panama. Note the excessively long barbels in the dorsal view.

Students of flying fishes, for long puzzled by the presence or absence of barbels, have in some cases been led to believe that "whiskers" are grown, or not, with little system, and that their presence or absence is of little significance. The present material, it is believed, will be able to prove, in several cases at least, that these structures are as regular in occurrence as they are in other groups of fishes. This will either mean the reestablishment of various species now resting as synonyms, or the creation of new species. A discussion of this would rapidly carry us into technicalities that only a specialist would care about.

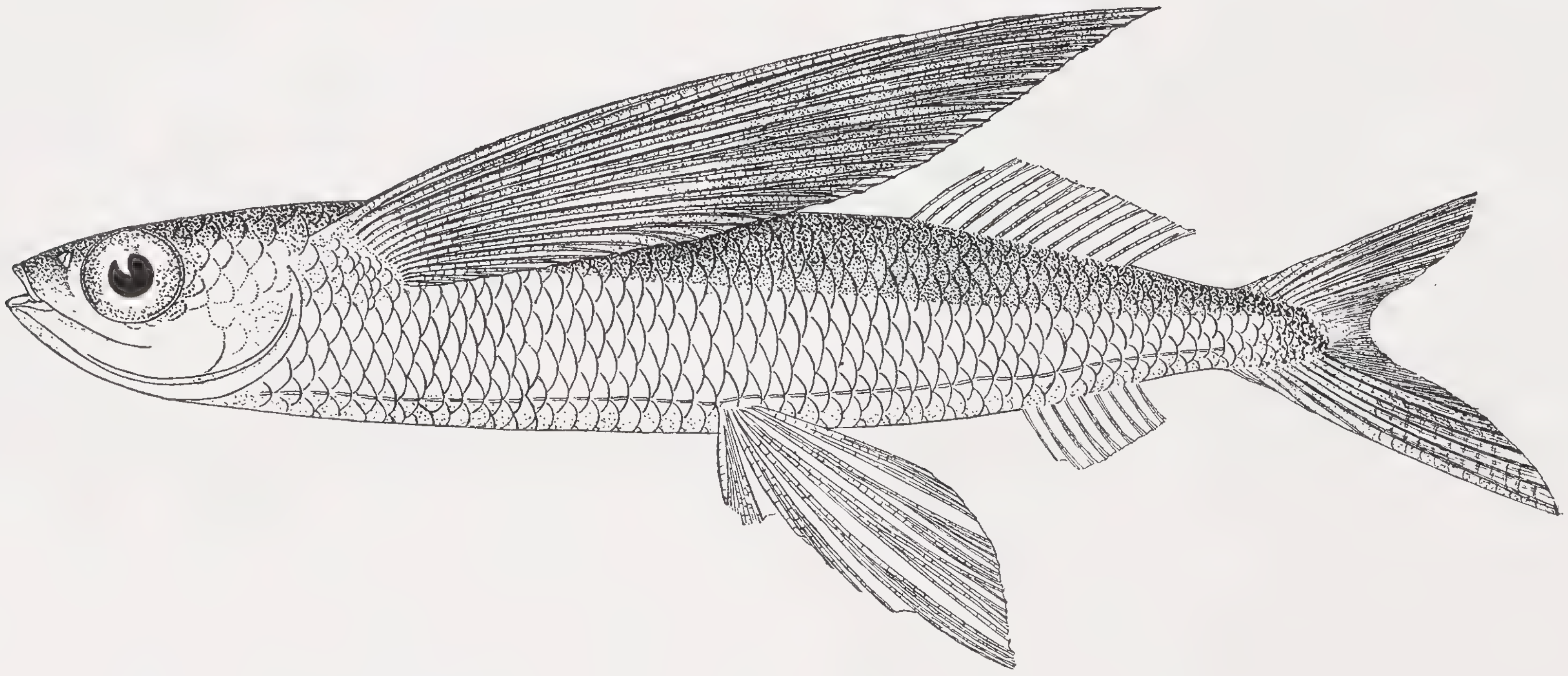
A considerable collection of flying fish nests and eggs was made by virtue of the sargasso collecting net. These are curious structures. The fish wind a long tough cord of a dead white color tightly about a single clump of sargasso weed. The eggs themselves occur in small clusters at intervals along this cord. Both the eggs and the cord are heavy structures and sink in sea water. Their attachment to the buoyant sargasso weed alone keeps them from sinking into the cold abyssal waters underlying the open ocean. Most other pelagic fishes produce buoyant eggs that float of themselves but the flying fishes have to seek some support for theirs, if the eggs are to remain within the environment in which they are capable of surviving. The eggs of one species, *Exonautes rondoletti,* were hatched on shipboard and allowed to develop to a recognizable size. This species, at least, hatches at a fairly advanced stage and soon feeds readily on small organisms. A continued supply of food was provided in a rather novel manner. Eggs of the brine shrimp *Artemia* may be dried and kept for years as a fine dry powder. When sprinkled on salt water they hatch out as tiny shrimp in about a day. The eggs of this curious crustacean may be taken in quantities in brine pools of salt-collecting establishments. Some time ago the San Francisco Aquarium Society began packing these eggs commercially for the use of home aquarists, and they have been used for such purposes with considerable success. This is the first case we



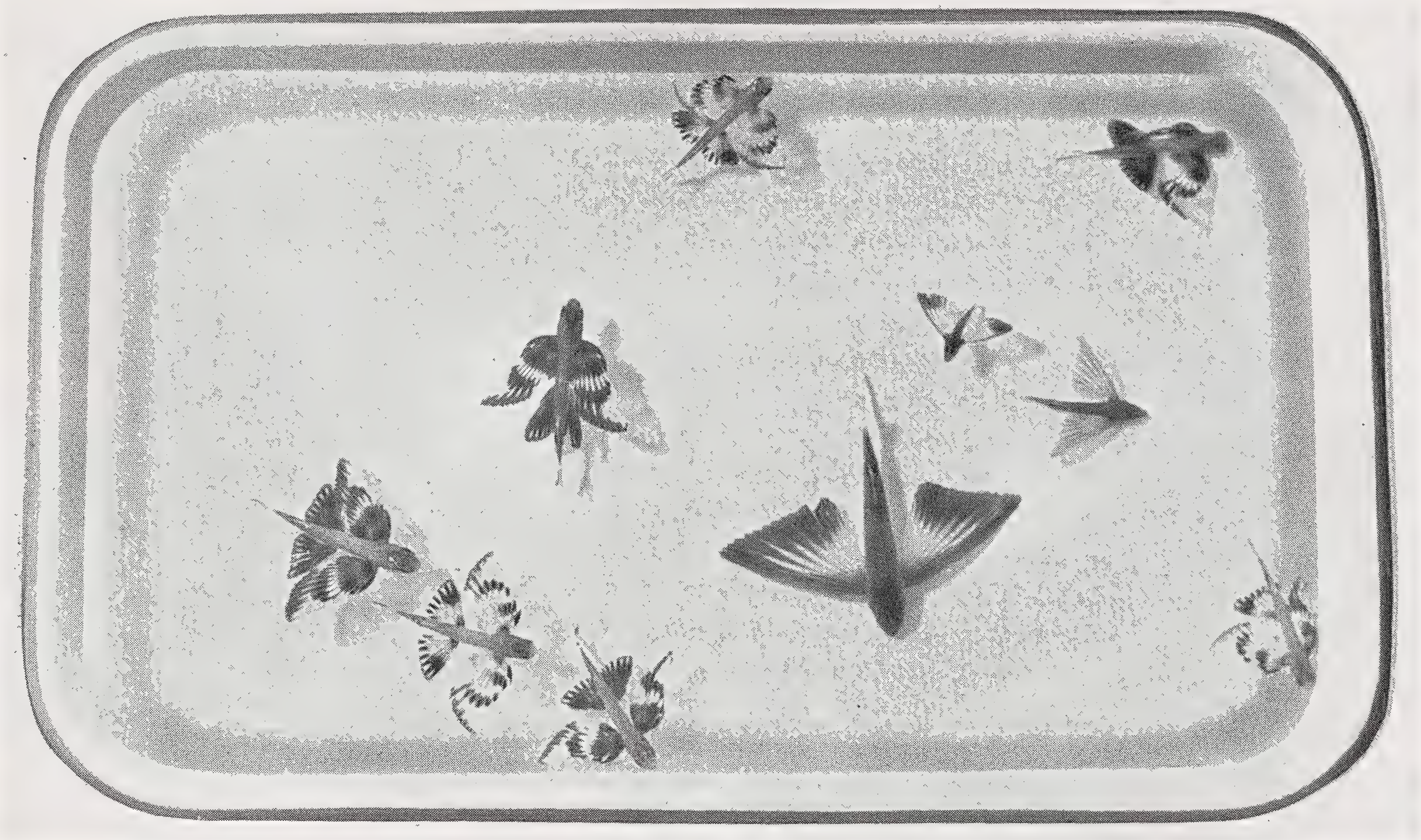
A basin full of flyingfishes. There are three species here which represent part of a night's collection of young fish. Three, with the solid black fins, are a species of "four-winged" flyingfish *Exonautes.* Those with the large, single pair of wings showing some pattern are *Exocoetus,* and the rest, with the smaller transparent wings, are *Paroxocoetus.* This latter kind possesses barbels on the chin, which may be seen in some of the specimens.

know of, however, where this method has been used as an aid to the scientific study of the development of ocean fishes. It may be pointed out that one of the chief difficulties in rearing pelagic fishes is in the matter of supplying the first food to the larvae just after they have absorbed the last of the yolk carried over from the egg. It is suggested that this technique might prove to be a valuable method for other similar fishes. At least it worked exceedingly well in the present case.

This species of flying fish apparently only uses one kind of weed, *Sargassum natans,* although other kinds may be just as available. In addition to selecting this certain species of weed, in all cases noted by us there were small sprigs of a relatively small and rare weed woven into the nest, *Sargasso myriocistum.* These small pieces occurred in the nests in numbers much out of proportion to the normal, relative quantities, as measured by the quantitative weed collector. How these odd bits were agglomerated



Lutkens flyingfish *Cypselurus lutkeni* (Jordan and Evermann), a species more common in the Caribbean than generally supposed. From a drawing by Jean Roddan.



A basin of flyingfishes taken on another night presented a quite different assortment than those shown in the other picture. Note that the three "two-winged" fishes *Exocoetus* have a different wing pattern. The others with four large wings bearing elaborate patterns are *Cypselurus*.

in the nest is a puzzle. Why the nests were so built is also a puzzle. It has been suggested that the berry-like floats of this small weed resemble fish eggs and are thus a protection. Actually they bear little resemblance in size or color and it is hard to believe that any animal bent on a meal of flying fish eggs would be deceived.

Although almost the entire trip was spent on the high seas in the pursuit of matters similar to the items above referred to, visits at two Caribbean ports did much to prevent monotony. At Jamaica various fresh-water fishes were collected, some of which were brought to the Aquarium alive. The curious semifresh-water pipe-fish *Oostethus lineatus* made an interesting addition. Other small fishes, from both the lowlands and high hill streams of this most beautiful of the Caribbean Islands, are also now living on lower Manhattan.

At Panama a visit to the Canal Zone Biological Station, Barro Colorado, is especially memorable. This station, an island paradise in Gatun Lake, also yielded some interesting living material. A small but handsomely marked fish *Rivulus brunneus* was brought to New York for the first time. The visit to this bit of jungle caused a rush of memories, for it was just ten years ago that the writer saw Panama, at that time part of an expedition to some of the little known hinterland. The Panamanian jungles are such that only an exceedingly obtuse person could forget. The spell of charm they cast is something one carries with one indefinitely.

After leaving Panama we all returned to our respective ocean problems, and had a steady run of it from there to Miami (Feb. 14 to March 5). This was the last port of call before the party broke up at New York, each member returning to his home institution with scientific plunder and profit.

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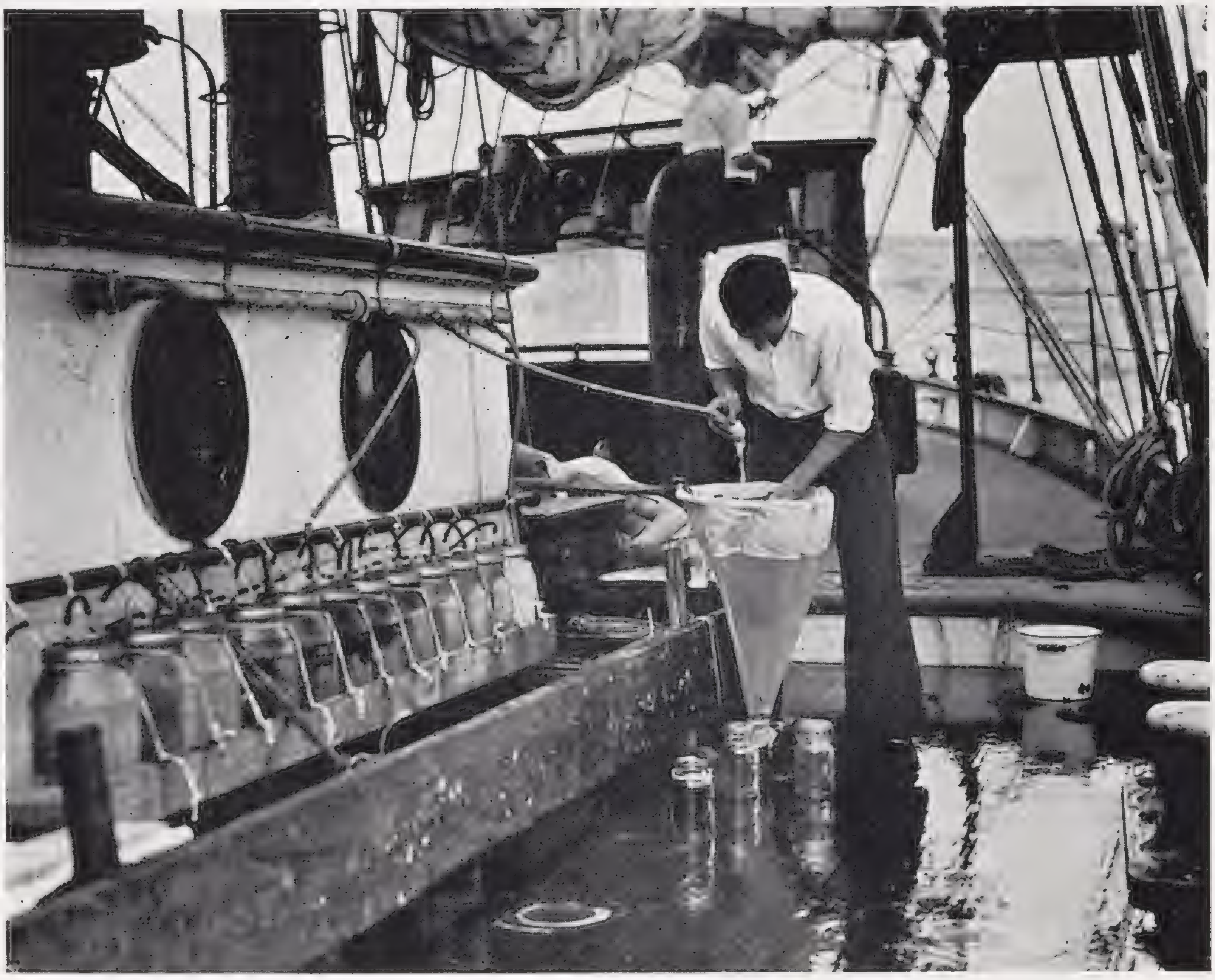
Problems of the Sargasso Sea

A. E. Parr

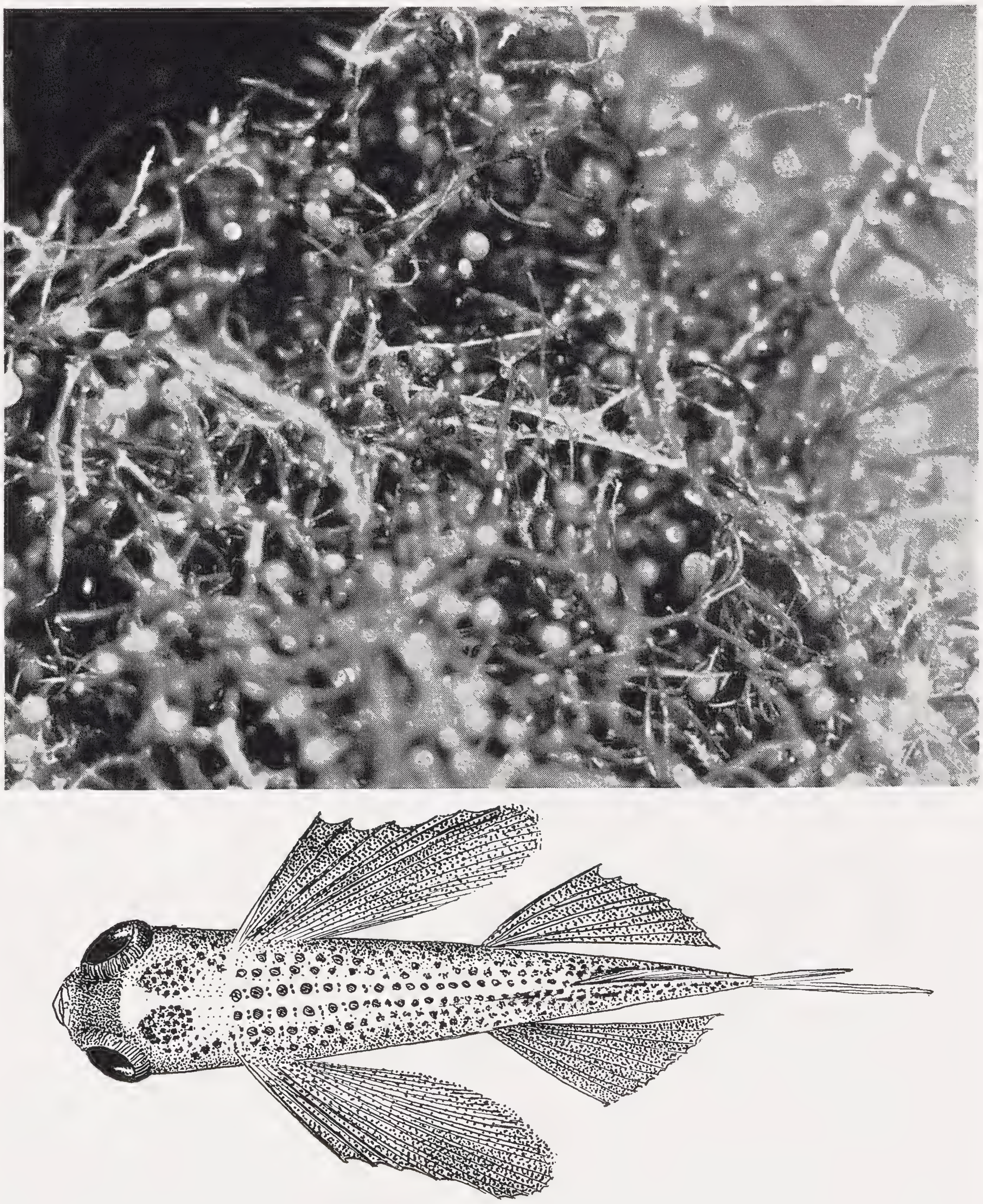
Curator, Bingham Oceanographic Collection, Yale University

FOR centuries the domain of the floating weeds on the high seas has been the subject of curiosity and superstitions among the seafaring man and travelers. Many weird tales of the sea have arisen around the mysterious forces supposed to be at work in the Sargasso, have



The battery of jars used for the study of Sargasso invertebrates, and the development of flyingfish eggs and larvae. Martin Burkenroad is seen washing small forms from a clump of weed.

A fresh-water pipefish *Oosteus lineatus* living in a balanced aquarium in New York. This particular specimen was collected in a small creek near Kingston Harbor, Jamaica, but they are also common at Barro Colorado in Gatun Lake, Panama, as well as in marine localities. Photo by S. C. Dunton.



A typical nest of *Exonautes*. The white cords to which the eggs are attached are clearly visible, a little above the center of the picture, against the darker weed. The larvae which hatch from these eggs in a few days appear as shown in the line drawing of a specimen a little over a half inch in length. (Drawn by Louise Nash.) Larger specimens are shown in one of the accompanying photographs of a pan full of fish.

made the rounds of the forecastles and the ports of the world, often finding their way at last into the literature and the movie drama.

And yet the Sargasso Sea, technically defined, is simply a part of the North Atlantic in which floating weeds very much like the common brown seaweed we may find any place on the rocks along our coast occur in sufficient abundance to make them a common sight from a ship passing through the region; and the mysteries it contains exist only in the biological problems of the weeds themselves and the many small animals and fishes that drift around with it, making up an entire floating world of their own. This world is unique among biological environments in water or on land in that it provides opportunity for an existence which is neither that of the bottom animals growing or crawling about on the ground, nor that of the pelagic animals swimming or drifting around free in the water or at

A friendly booby bird visits the *Atlantis* off the coast of Nicaragua. These birds sometimes visit ships in large numbers.

Collecting Poeciliids in the high hills of Jamaica. Marshall Bishop and the guide are examining the catch, while Harry Sears endeavors to capture more specimens.

The mountains forming the ridge of the continental divide run close to the San Blas coast of Panama and may be seen on approaching Colon Harbor. This view had poignant memories for the writer, as ten years previous he crossed the isthmus from the Pacific to the Atlantic through the virgin jungle a little to the south of this photograph.

the surface, but a strange mixture of both. A world in which animals by nature intended for bottom life drift around on an artificial, shifting and discontinuous "false" bottom of living, floating plants, often miles above the true bottom of the ocean, which they would probably never be able to reach without perishing on the way except in a narrow zone of shallow water along the shores.

Yet the Sargasso Sea, with its plants and animals in their precarious existence, stretches right across the North Atlantic from the Antilles and the Gulf Stream up to about 40° N in the west to the Azores in the east, with its southern boundary approximately along the parallel of 20° N, a distribution which corresponds very well with the area of the clockwise North Atlantic surface circulation with its convection centre.

When Columbus, on his westward voyage, first encountered the floating Sargasso weeds, his men mutinied in the belief that the weeds must be a sign of dangerous rocks being near, and this belief in a modified form has been the basis of much scientific theorizing and exploration concerned with the origin of the floating weeds, and is very hard to eradicate even today. Since similar weeds floating in great masses at the surface of the sea had never before been seen except close to shores where they were also growing on the bottom, the sailors' assumption that bottom must be near was perfectly natural and it was also natural that science at first should take the same view, looking upon the Sargasso Sea merely as a region of floating fragments torn loose by mechanical forces from enormous fields of bottom weeds with which they imagined the sea to be surrounded. When it later was discovered that the floating weeds

Deep jungle on Barro Colorado Island. The daylight strikes through the trees in places, but only poorly illuminates the forest floor.

After the sargasso weed is sorted, Bishop (left) and Greenwood (right) discuss some particularly curious specimen.

are never reproductive, but, if at all, merely multiply by growing at the tip of the branches and falling apart at the base, the belief gained further strength that the floating weeds were only short-lived fragments and that the Sargasso Sea itself was dependent upon a rapid and continuous replacement of its weeds from bottom fields.

But difficulties soon began to develop for this theory. In spite of considerable search, one has never as yet been able to discover any bottom fields of a size which would be at all significant for the Sargasso Sea. The bottom fields remain as hypothetical as ever, and it is one of the hopes of the writer to get an opportunity for a sufficiently thorough search of the shallow water areas of the Central American seas to be able to state definitely in the negative or affirmative whether any such fields are present at all. A further difficulty has arisen from the fact that among the many related weeds growing on the bottom none have been found to be entirely like the floating ones (*Sargassum natans* and *fluitans*), and it has thus been impossible to say definitely that even a single specimen of the floating weeds have been shown to exist in any other condition than afloat at the surface. In explanation of this, it has been suggested that the tearing loose of the weed constituted such a radical change in its mode of living that it would also cause a change in its external appearance, making it impossible to establish the identity of the floating and attached stages.

It is one of the objectives of the investigation now under way to attempt to test experimentally whether such a change would occur and to try to reverse it, in case it does happen, so that it may become possible to tell whether or not the floating weeds actually might be identical with any of the forms growing on the bottom.

One obvious objection against the assumption that the floating weeds represented short-lived fragments only, with no independent growth and existence, can be raised from the fact that it would in any event take a very considerable time for such fragments to be distributed over such a tremendous area (over two million square miles) and they would at least have to be able to live independently for as long as this process of distribution would require. It is furthermore well known that plants may go on multiplying by growth only, without any fructification, and there is no reason why we might not in the floating Sargasso weed find an extreme development of this condition, with normal reproduction completely suppressed. Another school of thought therefore developed around this idea of the Sargasso Sea as something probably derived from the bottom sometime in the dim past but developed into an entirely independent world today, able to maintain its existence by simple growth and mechanical division without significant contributions from the bottom. Although this is the viewpoint which has gained the greatest support in recent years among the scientists actually undertaking a serious study of the Sargasso weed problem, it has received almost no recognition outside of the narrow circle of specialists, and the Sargasso Sea still remains in the minds of most people an enormous eddy of flotsam from the surrounding shores and shallow waters.

Already as early as in the 1880's, the Germans began to require the captains of their merchant marine to record the frequency with which they encountered the floating weeds on their crossings of the ocean, and in 1891 appeared in print the first analysis, by Krümmel, of the tremendous amount of data thus accumulated by the "Deutsche Seewarte." From this material it has been possible to show that the floating Sargasso weeds are subject to a seasonal fluctuation in abundance, increasing sharply from a minimum during the summer to a maximum during the fall, followed by a slower decline during winter and spring to a new minimum again next summer. Since the increase occurs simultaneously over the entire area, it may be taken as evidence of an actual growth and multiplication of the floating weeds themselves and not of a sudden contribution from the surrounding shallow waters, since such an addition to the circuit would of necessity appear successively and not simultaneously at the various points of the Sargasso circulation. These statistics can therefore also indirectly be taken to support the theory of the independence of the floating weeds as recently pointed out by Winge.

The figures obtained by the "Deutsche Seewarte" were not truly quantitative, however, but merely expressed the frequency with which the weeds were sighted from ships. As to actual weights and volumes, no observations were available. It is perfectly clear, however, that the true place of the floating Sargasso weeds in the household of the ocean cannot be determined until we have some sort of an idea as to its actual quantity, the amounts of its requirements, and of its contributions to the sea. To this end the research ship *Atlantis,* on two cruises sponsored jointly by the Woods Hole Oceanographic Institution and the Bingham Oceanographic Laboratory of Yale University, has been making continuous tows over long distances with a net cutting out exactly a two-feet wide strip of the surface. When a sufficient amount of tows have been made, we shall be able to begin to make accurate estimates of weights and volumes. So far the surface tows made by the *Atlantis* on the two Central American cruises add up to a total towing length of more than two thousand miles, but we still feel that we are only at the beginning and many more figures must be obtained before we can begin to work out reliable quantitative averages of abundance for the different seasons and different areas and to arrive at an accurate total for the entire Sargasso Sea. We are probably entitled to say, however, that the total amount of floating weeds must be in the order of magnitude of ten million tons fresh (wet) weight; that is, it must be somewhere between 5 and 20 million tons. Although this is as close as we dare to make our estimate today, it nevertheless represents a great step forward from the previous state of our knowledge, when there was no information available from which we might even decide whether it was a question of thousands or millions or billions of tons. To determine what these millions of tons of floating weeds may mean in the household of the sea, it is further in the program of our investigations to have a complete chemical analysis of the weeds made and to undertake a series of biological experiments to determine the demands they make upon the ocean when alive.

Parallel with the investigation of the Sargasso weeds themselves, Mr. M. D. Burkenroad of the Bingham Oceanographic Laboratory is also carrying on a study of the intricate biological problems of the many invertebrate animals growing upon or living among the floating weeds.

Coelenterates as Enemies of Fishes
II. Jellyfishes as Fish-eaters*

Dr. E. W. Gudger
Bibliographer and Associate in Ichthyology, American Museum of Natural History

In paper No. I of this series, it has been shown that such a simple Coelenterate (hollow-bodied animal) as Hydra catches and eats baby fishes; and that the related Polypodium is parasitic *in* the ovarian eggs of the sturgeon of the Volga River. Of the colonial forms, two species of Hydrichthys (the fish-hydroid) are parasitic on fishes as far removed from each other as Durban Bay, South Africa, is from Narragansett Bay, New England. Then it was shown that two colonial forms catch little fishes with their tentacles and prey upon them. In this article, it will be demonstrated that, among the free-swimming Coelenterates, the Medusae also feed on fishes.

Medusae as Enemies of Fishes

Medusae in their intimate structure are composed like the simple coelenterate, Hydra, of an external ectoderm, an internal endoderm, with a structureless layer, the mesogloea, between. However, in them the nervous system (very rudimentary in Hydra and its allies) is quite well developed. As in Hydra, the nettling cells are largely confined to the tentacles.

Looking at the Medusae or Jellyfishes in the water, they are seen to consist of dome- or umbrella-shaped contractile bells fringed with tentacles, and depending from the center of the under side of the bell, like a clapper, is a hollow process or manubrium having a mouth at its extremity. The Medusa, with its circle of fringing tentacles dependent from the rim of the bell, gets its name from the mythical Medusa whose ringlets consisted of writhing serpents. And we shall presently see that the tentacles of our Medusa (armed with poisonous whiplash cells) are quite as deadly as the serpent ringlets of the mythical one.

Medusae do catch and swallow and digest fishes as many observers testify. But the presence of fishes under the bell and even in the stomach-cavity does not necessarily mean that these fishes are the prey of the jellyfishes. They may be in either place for shelter and protection. Doubt as to the inimical status of such a relationship was, I believe, first expressed by the great Cuvier. The relationship is in many cases a matter of doubt, but there is a considerable literature dealing with the undoubtedly friendly protection afforded by Medusae to various kinds of fishes. These fishes are generally few under a Medusa, but William Beebe and John Tee-Van in their "Fishes of Port-au-Prince Bay, Haiti" (*Zoologica,* 1928, *vol.* 10, *p.* 11), have recorded the amazing fact that from under a large jellyfish they took the prodigious number of 304 young fishes varying in length from 12.5 to 47 mm. (0.5 to 1.75 in.). This medusa with some of the sheltered fish is figured by Beebe in his "Beneath Tropic Seas" (New York, 1928, p. 30).

Jellyfishes do eat fishes, and in turn some of the fishes eat medusae; but it is in the predatory activities of the jellyfishes that we are interested here and to these we will now turn. And first of all it may be said that nearly all the writers of faunistic or general systematic works on the Coelenterata say that jellyfishes feed on fishes, but very few say "I have seen such and such a medusa eat a fish." Only those whose observations have been at first hand, will be quoted.

The jellyfish catches the fish by paralyzing it with the poison-cells with which its tentacles are thickly studded. It then enwraps the fish in its tentacles and transfers it to the mouth at the open end of the manubrium or bell-clapper.

The Discovery of this Habit

There is doubt as to who recorded the first observation of medusae as fish-enemies. Aristotle

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*Part I of this article appeared in *"Annals and Magazine of Natural History,"* 1934, 10. Ser. 13 Vol., pp. 192-212, 2 pls., 7 text-6.

is often so credited but the latest and most critical English version of the "Historia Animalium" of the Father of Natural History, that of D'Arcy W. Thompson (Oxford, 1910), very clearly states that the sea-anemone is the organism in question.

Lunel and others state that the Abbe Spallanzani (1776) was the first to observe a medusa catching a fish, and that Otto Mueller (1776) was the first to figure a jellyfish with a fish entangled in its tentacles. Further they allege that this figure has been much copied. Both statements are in error, since both apparently refer to the work of the old Dutchman, Martinus Slabber, whose figure and description will now be set forth.

Medusa cymbaloidea the First Jellyfish Fish-Eater

Slabber was so far as I have been able to find, the first to see, describe, and figure a medusa in the act of eating a fish. His observation was made in 1768 and ten years later he described and pictured this feeding in his "Natuurkundige Verlustigingen" (Haarlem, 1778, p. 101, pl. 12). His figures (A in natural size, and B much enlarged) are reproduced as Fig. 1. herein. Since these are the very first, it seems well not only to copy the figures but to give a translation of Slabber's brief statement. He thus records the facts concerning what he calls *Medusa cymbaloidea*—the cymbal-shaped medusa:

> As soon as I had caught it, I placed it under the microscope [probably a simple affair] and found that it had caught a very small fish [Fig. 1A shows this in natural size] for its prey, which could still be seen outside of the body [Fig. 1B] . . . [the fish] was very lively when I looked at it, and one could see plainly that it was being drawn in. This drawing-in was completed in two hours time and then the whole creature [was enclosed in the manubrium] . . . The mode of feeding was an interesting sight to me and it places me in a position to be able to report the real [feeding] habits of the animal, since before I had only at best been able to guess at them.

Slabber then argues that with millions of jellyfishes in the North Sea there must be a great consumption of little fishes with a corresponding reduction of fish available as food for man. This particular matter will again be referred to at the close of this article. Slabber concludes with an accurate and interesting observation concerning the tentacles, when he says that "These streamers when stretched out have . . . a great resemblance to snakes and serve the jellyfish to get control of its food."

Slabber's figure has been often copied. I find it in at least two of the works of George Brown under the name of "Medusa campanella." And since Brown makes this synonymous with O. Mueller's "Medusa hemisphaerica," I suspect that this is how Lunel and others credit Mueller with the first figure of a Medusa eating a fish. Mueller's figure, however, is on an entirely different medusa and there is *no* fish shown.

Other Accounts of Medusae as Enemies of Fishes

Having introduced the reader to this habit of jellyfishes, from this point forward the data will be collected and set forth under the names of the individual medusae. No attempt will be made to reduce these names to synonymy, since my interest is in the fish-eating habit of the medusae and not in their classification and nomenclature.

The data contained in this article have been gathered from a number of widely scattered sources but, while isolated records of this behavior are both interesting and valuable, still effectually to answer the question whether the Medusae feed on fishes, controlled experiments are needed. These have been made by Dr. Marie Lebour at the Plymouth (England) Marine Biological Laboratory, and have been reported on in two excellent papers.[1]

It was realized that jellyfishes are the largest and most voracious feeders of the plankton or surface dwelling organisms and that in them were frequently found partly digested young fishes. Then the question arose as to whether these baby fishes were caught alive and eaten out in the sea under natural conditions, or whether

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[1] The Food of Plankton Organisms, No. 1. *Journ. Marine Biol. Assoc. U. K.*, 1922, n. s. 12, 640-677, 3 text-figs.—No. II, *ibid.*, 1923, n. s. 13, 70-92, 12 text-figs.

The second of these papers has been briefly and inadequately summarized by Louis Joubin *as* "La Destruction des Petits Poissons par les Animaux du Plankton". *Bull. Soc. Océanogr. France*, 1924, 4 ann., 380-382, 8 text-figs.

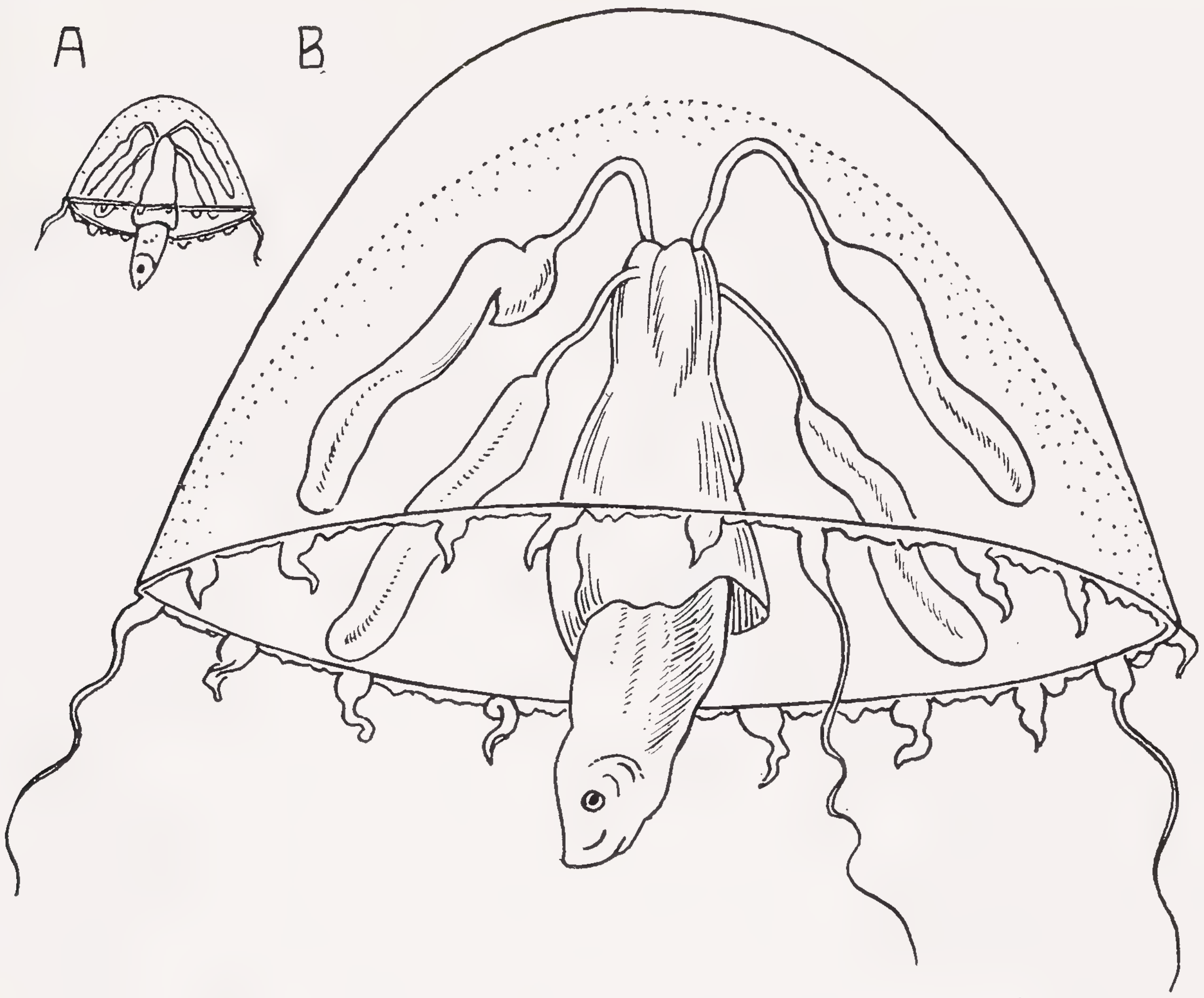


Figure 1. The first published figure of a jellyfish capturing a fish. A. *Medusa cymbaloidea* and the fish in natural size. B. The same enlarged six times to show the swallowing process. After Martinus Slabber, 1778.

the jellies swallowed the half-dead fishlets in the crowded tow-nets. To settle this question, extensive aquarium experiments were carried on for months and careful notes and drawings made. Large numbers of small medusae and fishes were kept in jars (of 50 litres capacity) and most of the medusae were seen to catch and eat fishes. The fishes caught by the tentacles were conveyed to the mouth and by it ingested, and were digested in the stomach. Of little fishes, put into the aquarium to test the feeding of the medusae, some were newly hatched ones from the hatching-jars in the laboratory and other somewhat older ones were from the tow-nets and the trawls for catching young fish.

The observations of Dr. Lebour and other naturalists will now be set out under the names of the various medusae concerned. The scientific names will have to be used since in most cases there are no common ones.

Aurelia aurita, an Enemy of Fishes

That this widely distributed jellyfish is a feeder on fishes has long been known. Thus but two years later than Slabber, Otho Fabricius, in his "Fauna Groenlandica" (1780), notes that *Aurelia aurita* feeds on little fishes, especially on the young of the sea-scorpion, which it thrusts into its stomach. This Fabricius apparently saw with his own eyes.

That Aurelia feeds on fishes seems to be widely believed (and probably known) but not until 1905 do I find a positive statement confirming Fabricius. In that year Prof. C. W. Hargitt in his "Medusae of the Woods Hole Region" (*Bulletin U. S. Bureau of Fisheries,* vol. XXIV, 1905) expressly states that Aurelia is frequently taken with stomach crowded with fishes of considerable size, and to settle the status of the fishes he notes that these are often partially digested.

We now come to the experiments of Dr. Marie Lebour at the Plymouth Laboratory. In the first one a young Aurelia measuring about 5 mm. was put in the aquarium on February 9. At first it stung the fishes with its lappets or lobes and enveloped them with the whole umbrella, but as it grew larger it caught them with the tentacles. Careful records from February 17 to March 30, showed that it was observed to catch and eat two sand-eels (*Ammodytes tobianus*), 6—7 mm. long; 8 sea-scorpions (*Cottus bubalis*) about 5 mm. long (+ 20 newly hatched ones in 30 minutes on March 13); 5 worm-pipefish (*Nerophis lumbriciformis*), about 12 mm. long; 8 young gobies (*Gobius minutus*) about 3 mm. long; and many uncounted other fishes including a 15 mm. dab. Then came a dearth of young fishes, but over four days toward the close of April it ate many gobies, and was ready for more. During May and June it ate several young pollack from 15 to 20 mm. long, and during July it ate one to three pipefish a day until near the end of the month when it died—possibly from too constant a fish diet.

The following year (1923) Dr. Lebour continued her experimental work. Young Aurelias fed freely on young fishes and those of 20—25 mm. in diameter were found with little flatfishes and clupeoids in their stomachs. Those above 30 mm. were not found to contain fishes. Why feeding on fishes in aquariums stopped at this stage is a matter for further study.

Another account of the feeding habits of Aurelia, I owe to the courtesy of Dr. C. J. Fish, the well-known planktonologist, who in a recent personal letter says that "At Woods Hole I have observed the young of Aurelia, even in the early stages, feeding on the larvae of winter flounders. In such places as Waquoit Bay, where both animals breed in abundance, Aurelia proved of very vital importance in depleting the flounder stock."

MEDUSA PHOSPHOREA, A FISH-CATCHER

Following closely after Slabber (1778) and Fabricius (1780), the Abbe Spallanzani made known in 1793 that this medusa also catches fishes. In Vol. IV, chap. xvii, of his "Viaggi al le due Sicilie," he records his observations on the phosphorescence of this medusa and states that he saw ". . . a little fish which had been caught by the viscid humor of the tentacles." Then he adds that the Sicilian fishermen reported that this was not uncommon in the Strait of Messina.

LIRIOPE SCUTIGERA, A DEVOURER OF FISHLETS

Liriope (a fountain-nymph) bearing a shield, a very transparent and rather small jellyfish, was convicted as far back as 1859 of catching fishes. In that year, John McCrady gave, in the *Proceedings Elliot Society of Natural History* (Charleston, 1859, vol. I, p. 209), the following interesting testimony (unfortunately without a figure):

> It is bold and rapid in its movements and very rapacious. I have seen one of this species—so extremely diaphanous as to make the impression of nothing but a set of outlines—seize upon a small fish fully thrice as large as itself, and securing itself by spreading out its lips upon it, making them act as suckers, and then entangling about the poor animal its four long tentacula, hang on in this manner despite the violent struggles of the fish, which alarmed, swam violently about the jar, until at last apparently from sheer exhaustion, it was evident he was dying. At last changing color, the fish turned over on its side and expired.

DACTYLOMETRA QUINQUECIRRA CATCHES FISHES

The generic name, (finger-measure) of this beautiful yellowish-blue medusa seems to have no particular significance, but the specific name designates the five rays between each pair of sense organs. Since there are 8 pairs of these, there are 40 tentacles in addition to the 48 marginal lappets or lobes. Despite these 40 tentacles armed with millions of nettle-cells, a species of clupeoid fish takes refuge under the umbrella of this medusa. As many as 20 little fish have been found under one medusa. According to A. Agassiz (*Memoirs Museum Comparative Zoology,* 1865, vol. I, No. 2), these clupeoids are so much at home that, if they are accidentally separated from their medusa they precipitately rush back, adroitly dodging in between the deadly tentacles. However, in base ingratitude, they sometime (presumably when food is scarce) feed on the pendent lobes of their protector. In turn one of these fishes every once in a while pays the penalty of this ingratitude by being stung and eaten in turn by the medusa. Agassiz says "I have seen in this way three fishes eaten during the course of as many days."

THE RAVENOUS CHARYBDEA XAMAYCANA

This formidable generic name, like many other zoological terms, has a very interesting origin. Charybdis was a ravenous woman who was transformed by Jupiter into the treacherous whirlpool off the Sicilian coast. The specific name is a West Indian word of unknown derivation. Conant, in his work on the Cubomedusae (*Memoirs Biological Laboratory Johns Hopkins University,* 1900, p. 7), notes the fitting origin of the name of his medusa, but unfortunately gives no figure to illustrate the following graphic account of the activities of this ravenous coelenterate. Here are his own words:

> Some of the specimens taken [in Kingston Harbor, Jamaica] contained in the stomach small fish so disproportionately large in comparison with the stomach that they lay coiled up, head overlapping tail. The name, Charybdea, then, from the Greek . . . seems no misnomer. It is worth mentioning that the digestive juices left the nervous system of the fish intact, so that from the stomach of a Charybdea could be obtained beautiful dissections or rather macerations, of the brain, cord, and lateral nerves of a small fish.

CYANEA ARCTICA, THE GIANT OF THE TRIBE

This "arctic-dwelling" blue jellyfish is cosmopolitan in northern cold oceans and seas. It is the giant of the great group Coelenterata. According to Hargitt (1905) its flat discoid "umbrella" is sometimes several feet across, while its tentacles are 50 or more feet long when fully extended. But, great as was Hargitt's specimen, Alexander Agassiz saw a larger one, of which he writes that "I myself measured a specimen at Nahant (Massachusetts) the disk of which had attained a diameter of seven and a half feet, the tentacles extending to a length of 120 feet." Furthermore, this great medusa is multitentaculate, having according to A. G. Mayer about 800 tentacles.

This great jellyfish must be a voracious feeder and numerous fishes must be caught in these many long sweeping tentacles. Hence one is prepared for Hargitt's statement that these great Cyaneas "are often found with their stomachs filled with fish of considerable size, some of which are often in a partially digested condition."

CYANEA CAPILLATA CAUGHT IN THE ACT

This blue jellyfish with many hair-like tentacles is also a fish-catcher, and this habit has been recorded in a series of photographs showing the stages of capture of the fish. This is most fortunate for there is a great paucity of figures showing this habit in larger medusae. These voracious activities of *Cyanea capillata* will now be shown in the figures referred to (Figs. 2 to 5 herein). These are made from photographs by C. O. Bartels at Kiel and published in his book appropriately entitled "Auf frischer Tat"—"Caught in the Act"—(Part I, Stuttgart, 1910, series 15). These figures studied in sequence make the capture of the fish so clear that little explanation is needed. The Cyanea photographed was a comparatively small one, only about 2¼ inches in diameter. A larger one would not have been so easy to photograph.

In Fig. 2 (Bartel's No. 1) we see that a pipefish swimming by a jellyfish strikes two or three tentacles. The batteries of nettle-cells on these erupt and throw out on the fish many nematocysts and much poison. The fish struggles but becomes entangled in more tentacles as may be seen in Figure 3 and is drawn nearer the mouth. In Fig. 4 all resistance on the part of the fish has seemingly ceased, and, suspended in the tentacles as if in a net, the posterior part of its body is brought closer still to the mouth of the jelly. Finally, in Fig. 5, the tentacles are seen almost completely retracted, and the fish, enveloped in these, is drawn up under the umbrella and close to the mouth of the Cyanea.

It should be emphasized that these figures are copied from photographs—the only ones ever made of this phenomenon, so far as I know.

GONIONEMUS MURBACHII, A FISH-CATCHER

This small medusa (its bell attains a diameter of only 15 to 20 mm.) is very common at Woods Hole, Massachusetts, where it has been much studied. Professor H. F. Perkins states that though small, it is a deadly foe to all baby fishes that cross its path. In a letter he gives in detail how one medusa captured and ate a fish. He placed in an aquarium a small Fundulus and eight mature medusae measuring from 12 to 18 mm. across the bell and accurately timed their reactions. Here is what took place:

> It took eleven minutes for the fish to blunder into a medusa. In six minutes more it was completely wrapped up in its hostess and all struggles had ceased. The medusa immediately applied its lips to the fish and in seven minutes had succeeded in engulfing it. The camera was ready and the specimens, one inside the other, were transferred to a small dish and photographed with the camera pointing vertically downward at the medusa. The last sign of any contents in the stomach was seen as late as six hours afterwards, and this was a piece of the backbone of the fish.

Professor Perkins has kindly loaned me the negative, but since he had no way of lighting the specimens from beneath and since the fish was obscured by the thickness of the disk of the medusa, the negative is very "thick." The Fundulus shows up in it as such a dark mass that no details can be made out and hence it hardly seems necessary to reproduce it herein.

Perkins writes further that he saw another capture. A little pipefish was dangling from the manubrium of a Gonionemus which had suc-

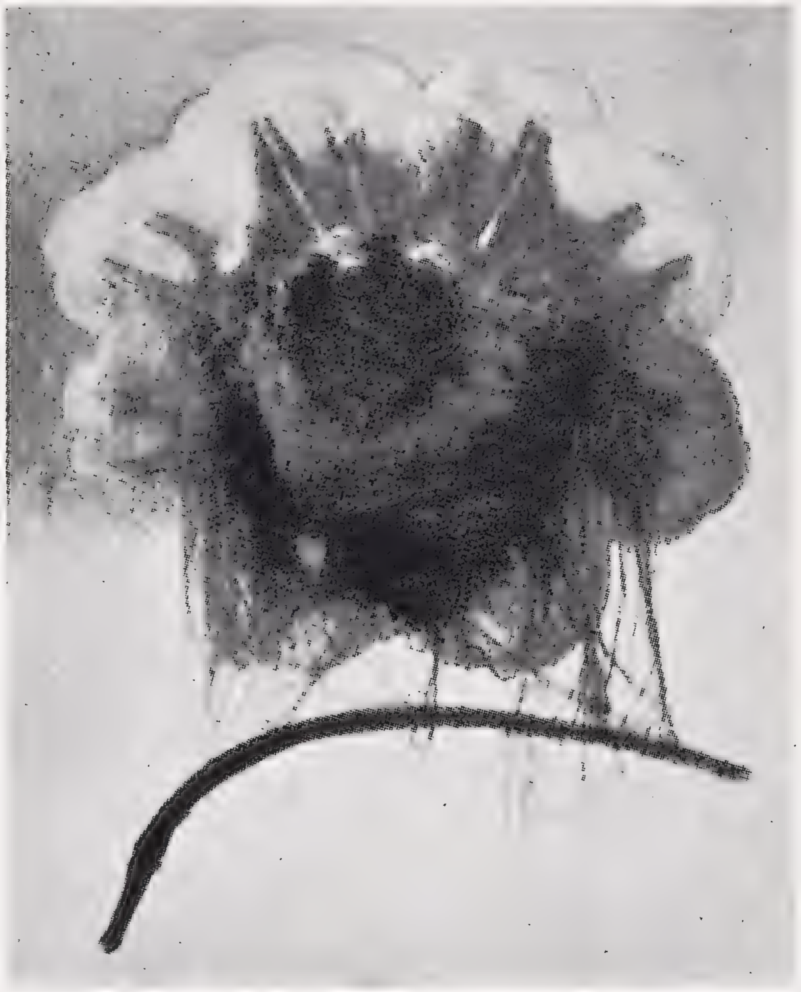
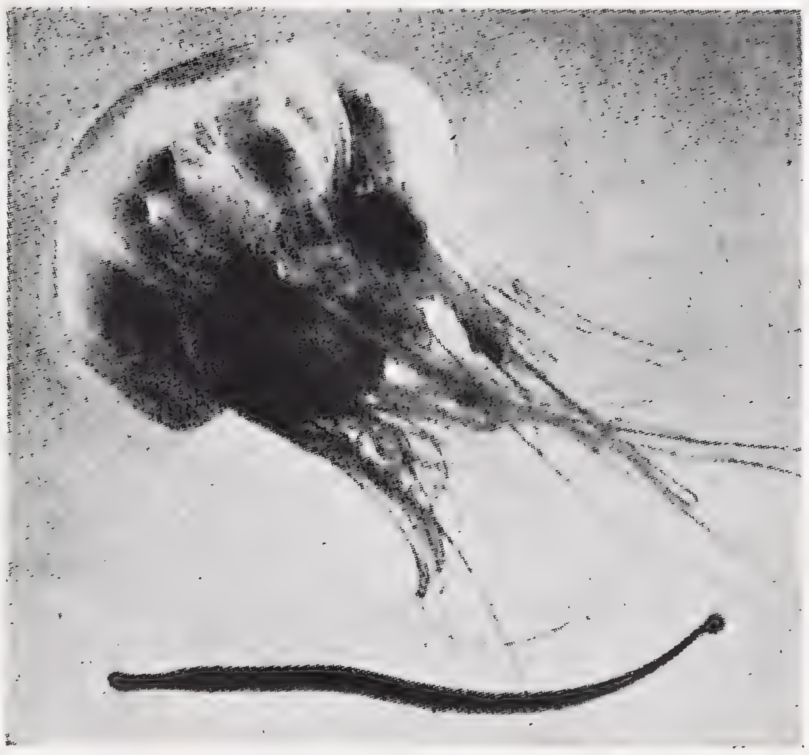


Figure 3. (Left) The many-tentacled Medusa catching a fish—II. Caught by more than a score of tentacles the pipefish is drawn to the Medusa. After Bartels, 1910.

Figure 2. (Below) The Hairy Medusa, *Cyanea capillata*, catching a fish—I. A pipefish swimming by is caught by three tentacles. After Bartels, 1910.



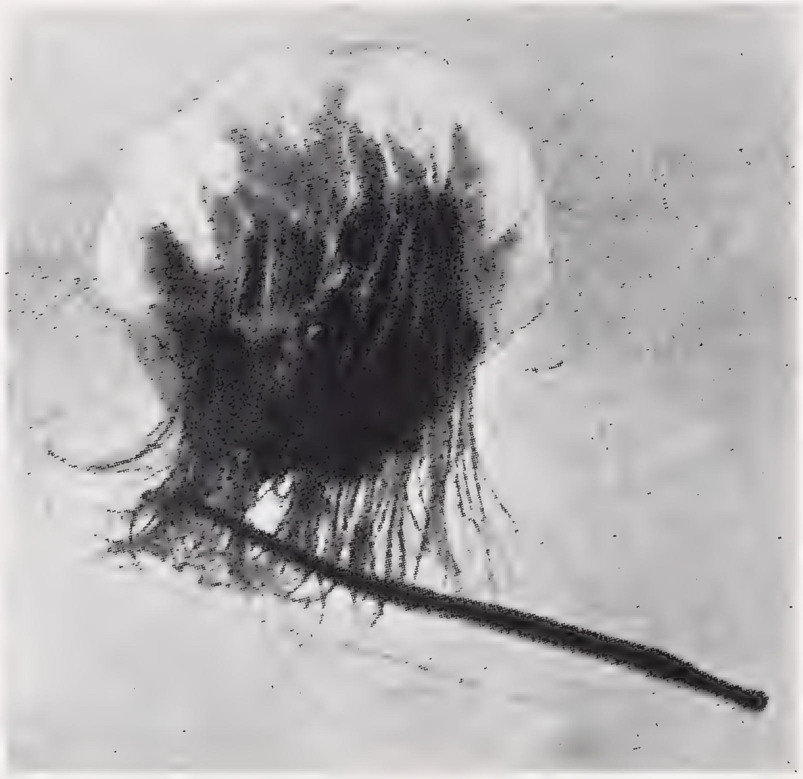


Figure 4. (Above) *Cyanea capillata* catching a pipefish—III. The anterior part of the fish's body is free, but the hinder half is enclosed in a meshwork of tentacles. After Bartels, 1910.

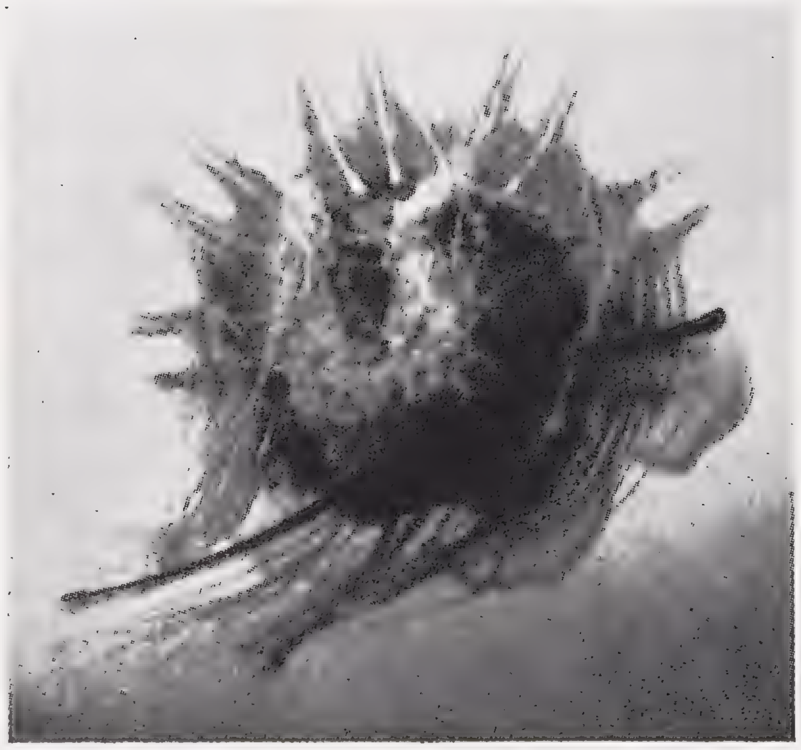


Figure 5. (Right) Cyanea catching a pipefish—IV. The pipefish now securely enmeshed in the tentacles is drawn close to the mouth. After Bartels, 1910.

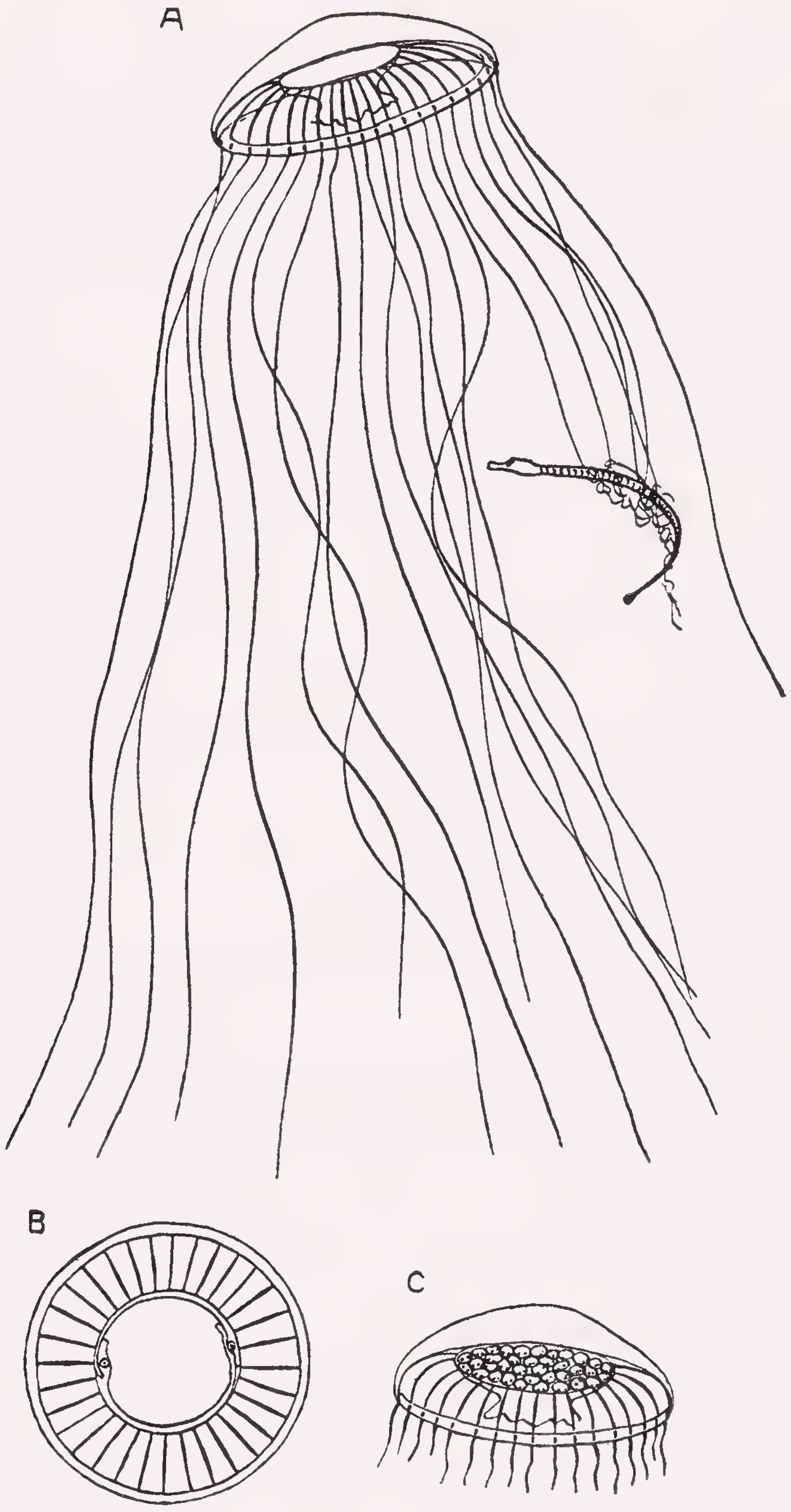


Figure 6. Young Aequorea feeding in an aquarium. A. A pipefish is snared by five tentacles. B. Two pipefish in a curious head and tail position in the stomach of the medusa. C. An Aequorea with the stomach filled with blennies. After Lebour, 1923.

ceeded in swallowing only the head. Apparently the medusa satisfied its hunger, for presently it dropped the fish.

Other like observations have been made on Gonionemus at Woods Hole. Thus Prof. R. M. Yerkes noted that among other things it ate small fishes, and in a letter to me he writes that he saw this take place a number of times. This is confirmed by Hargitt (1905), who states that Gonionemus and other small medusae often "gorge themselves with fry frequently too large to be swallowed."

The Ichthyophagous Aequorea

Two of these flat-disked medusae (species not determined), 32-40 mm. in diameter were put in the aquarium. They caught their prey with their tentacles (about 180 mm. long) and ate young blennies, pipefishes and Lepadogasters. The pipefishes were their especial *pièces de resistance,* one to three being eaten every day. Fig. 6A shows how a pipefish was caught by 5 tentacles. In Fig. 6B is shown a particularly neat head-and-tail arrangement of two others in the stomach of an Aequorea. The medusa shown in Fig. 6C is filled chock-a-block with blennies, and while digestion goes on it is quietly resting with retracted tentacles.

This data and much of that to follow are from Dr. Lebour, unless stated to the contrary.

Arachnactis bournei Catches Fishes

Bourne's spider-rayed medusa is so named from the long threads protruding from between the tentacles and used to catch little fishes. Dr. Lebour (1922) saw one catch a young sole and saw young sea-scorpions and blennies in its stomach. So it also must be put down as an enemy of young fishes. No figure is given.

Bougainvillea Britannica a Fisherman

This British medusa, from a genus named for the great French navigator and explorer, Bougainville, is also a feeder on young fishes, as may be seen in Fig. 7. This very small medusa from the tow-net had caught a young sand-eel very much larger than itself, and with its lips tightly appressed was holding it fast when sketched. It must be put down as a feeder on little fishes.

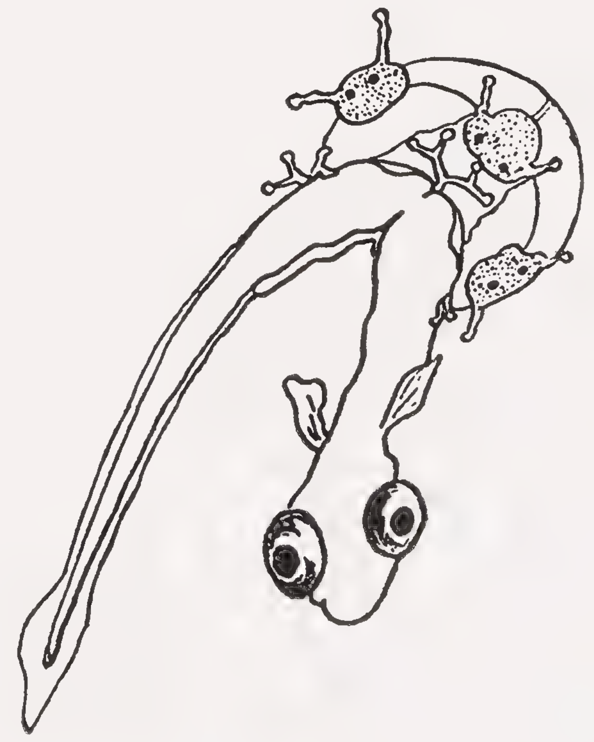


Figure 7. The British Bougainvillea eating a baby sand-eel. The little medusa holds the much larger fish securely. After Lebour, 1923.

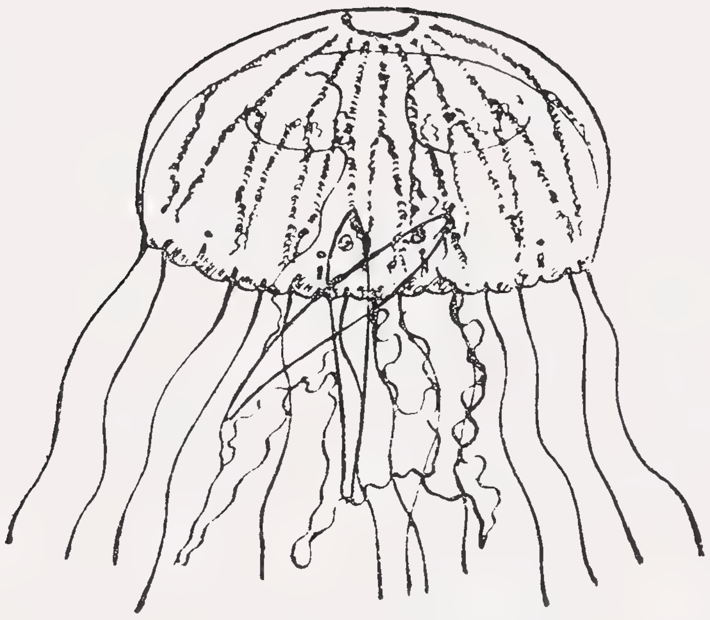


Figure 8. The Golden Sword Medusa with two captured pollack. The fishlets are held fast by *Chrysaora isosceles*. After Lebour, 1923.

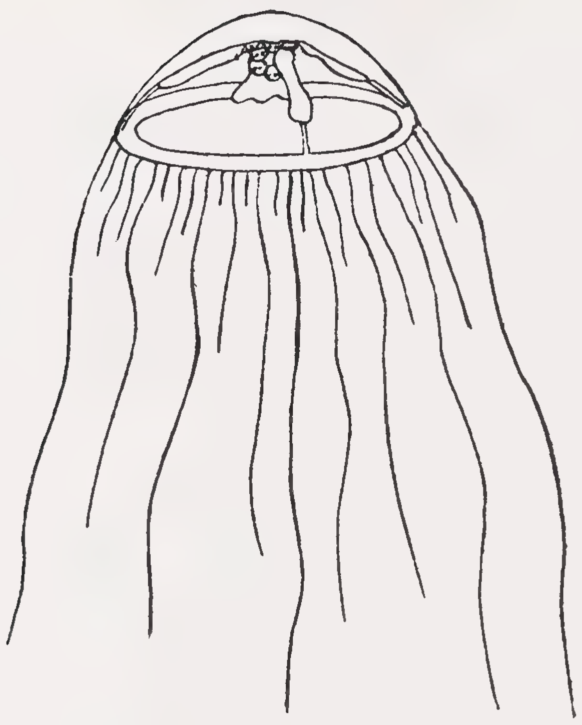


Figure 10. The Wave-riding Laodicea a fish-feeder. Three young blennies are seen in the stomach. After Lebour, 1923.

Chrysaora isosceles Feeds on Fishes

This formidable name means the three-edged golden sword, probably in reference to the bright chestnut-brown tentacles of the medusa. It also is a dangerous foe to little fishes as Fig. 8 shows, for in the one figured are contained two small pollack. Specimens of this medusa were also seen (during both seasons) to feed on little cottids, blennies of two or three kinds, gobies, rocklings and even sticklebacks. They ate other plankton but preferred fishes—of almost any kind. The jellies measured about 25 to 60 mm. across, while the fishes were from 25-35 mm. long. Chrysaora is very voracious, rapidly catching fishes until the stomach is full—sometimes as many as four of the larger fishes were caught consecutively and within a few minutes.

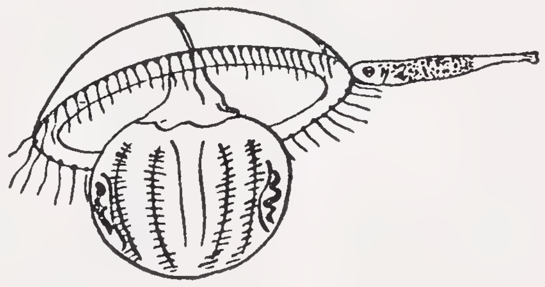


Figure 9. The Hairy Cosmetira a fish-catcher. A fishlet has been snared by the tentacles and a comb-jelly is held by the mouth. After Lebour, 1923.

Cosmetira pilosella a Fish-eater

That the hairy (or many-tentacled) Cosmetira is well named, is shown in Fig. 9 where one is seen trying to swallow a Ctenophore (comb-jelly) quite as large as itself and has snared a little wrasse (*Labrus*) which would itself make a full meal for the 15-mm. medusa. The medusa also caught young cottids and Lepadogasters. When ready to feed, its tentacles are long and whiplash-like, but when digesting the prey they are very much contracted as the figure shows.

The Voracious Laodicea undulata

The wave-riding Laodice is also a fish-eater. The one depicted in Fig. 10 (*circa* 11 mm. wide) while in the aquarium " . . . caught and ate several young blennies, *Blennius pholis*, catching them quickly one after the other with its outstretched tentacles, until the stomach was full." At least three are contained in the stomach as shown in the figure.

Obelia geniculata an Enemy of Fishes

The Obelia with bent or jointed knees (referring to its whiplash-like tentacles) is very small, the one in the aquarium measuring but 4 mm. in diameter. It was not seen to catch small fishes, but from tow-net captures Dr. Lebour proved its fish-eating habits. Two contained young whitings, one a clupeoid, and three had captured baby dragonets. The Obelia with "bended knees" is a miscellaneous feeder which includes fishes in its diet. No figure was drawn.

Phialidium a Destroyer of Young Fishes

The bowl-shaped medusa (so the name translates) was seen by Dr. Lebour (1922) to catch fishes as Fig. 11 shows. Directly a fish struck a tentacle it was benumbed and, several tentacles and the umbrella helping, was carried to the mouth. If there was difficulty the jelly would turn upside-down and the fish would be dropped into the manubrium. Sometimes a strong fish would break away, and sometimes as much as 40 minutes were consumed in getting the prey to the mouth. In this way Phialidium (species not determined) was seen to eat young sea-scorpions, sand-eels, armed bull-heads, soles, blennies, gobies, clupeoids and wrasses. Various other plankton were eaten but fishes were seemingly preferred, and were digested in 5—6 hours.

Of similar habit on this side the water, Dr. C. J. Fish writes that:

> During the year 1932, at the height of the herring spawning season in the vicinity of the Bay of Fundy, it was found that Phialidium formed an important enemy of the fry. For example, on our August cruise, at one station in the Bay of Fundy, 356 herring larvae were taken, 16 of which were in the stomach of Phialidium and 53 others showed signs of being partly digested before being released, probably in the net.

THE EVER-HUNGRY RATHKEA OCTOPUNCTATA

Rathke's eight-spotted medusa (named for the distinguished German zoologist), kept in Dr. Lebour's aquarium, never ate fishes but those from the tow-nets were often found attached to fishes, and continued to feed when placed in containers. In one case a small specimen had caught a baby herring many times too large for it, and infinitely too great to be taken into the mouth (Fig. 12A), but nevertheless was clinging fast to it with its labial tentacles. In another, which had medusa-buds on its manubrium, one of these buds had caught a young sprat as shown in Fig. 12C. Another had a young sprat sticking out of its mouth—see Fig. 12B. A few other records are young sprat in two, young herring in one, unidentified clupeoids in six.

The voracious Rathkea does not seem to mind tackling a fish much larger than itself.

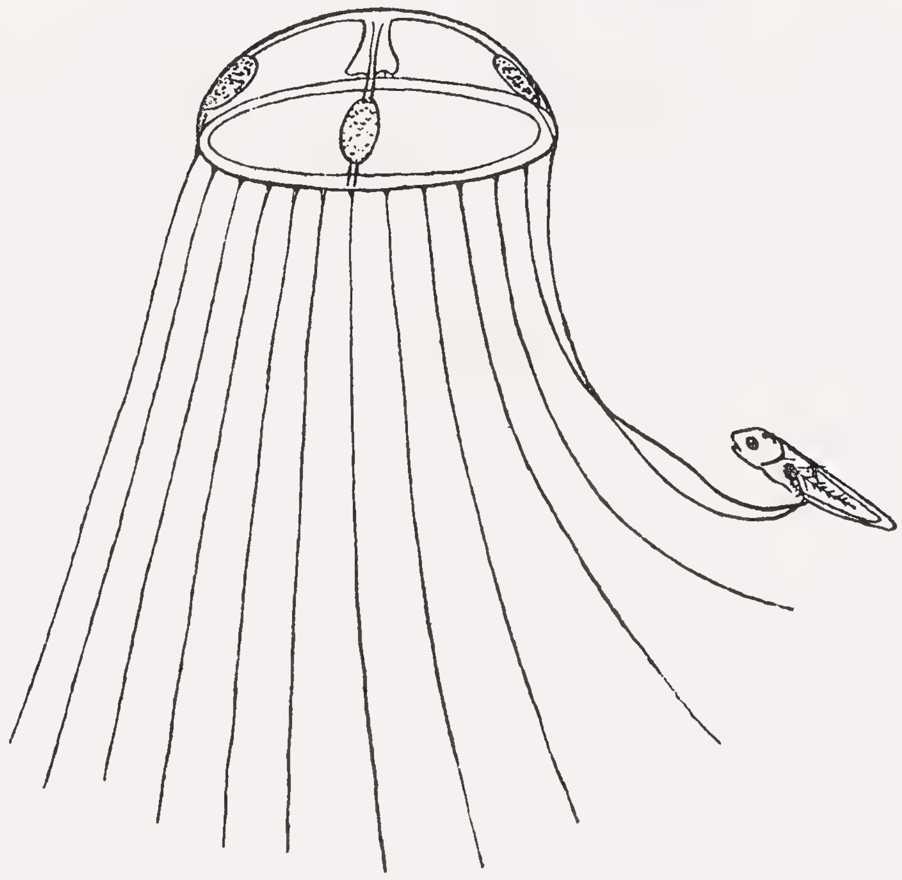


Figure 11. Phialidium snares a fish. Two tentacles hold the fish securely. After Lebour, 1922.

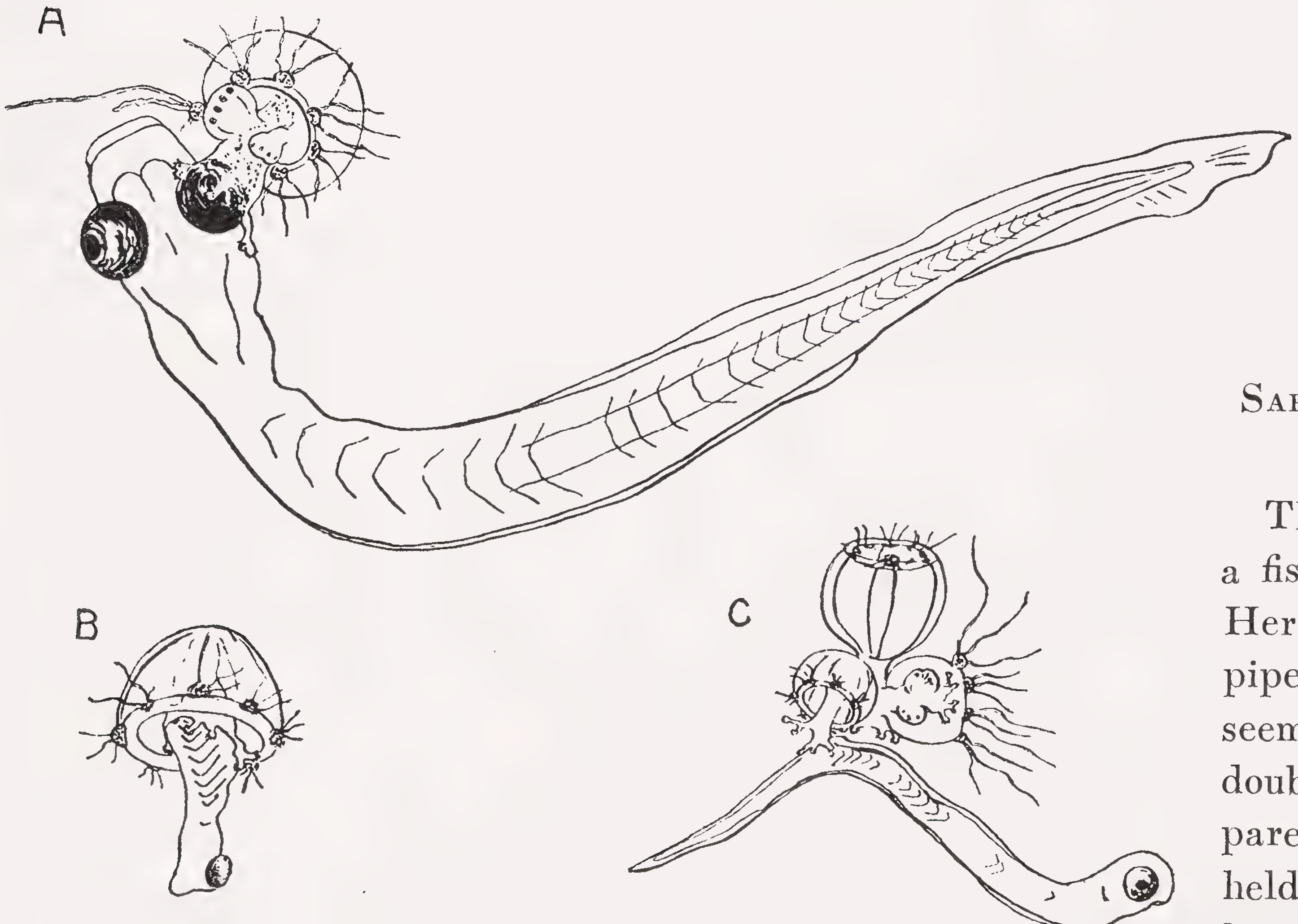


Figure 12. The Eight-Spotted Rathkea a fish-catcher. A. A very small medusa with its mouth has laid hold of a young herring many times larger than itself. B. A medusa is holding a young sprat in its manubrium. C. One of a group of medusa-buds has captured a young sprat. After Lebour, 1923.

SAPHENIA GRACILIS CATCHES A PIPEFISH

The graceful Saphenia is also a fish-feeder as Fig. 13 portrays. Here the medusa has caught a pipefish (these various medusae seem fond of pipefishes) with a double turn of its manubrium. Apparently this would securely have held the fishlet, but one is glad to have Dr. Lebour say that after a lengthy struggle the little pipefish got away. Other prey was taken

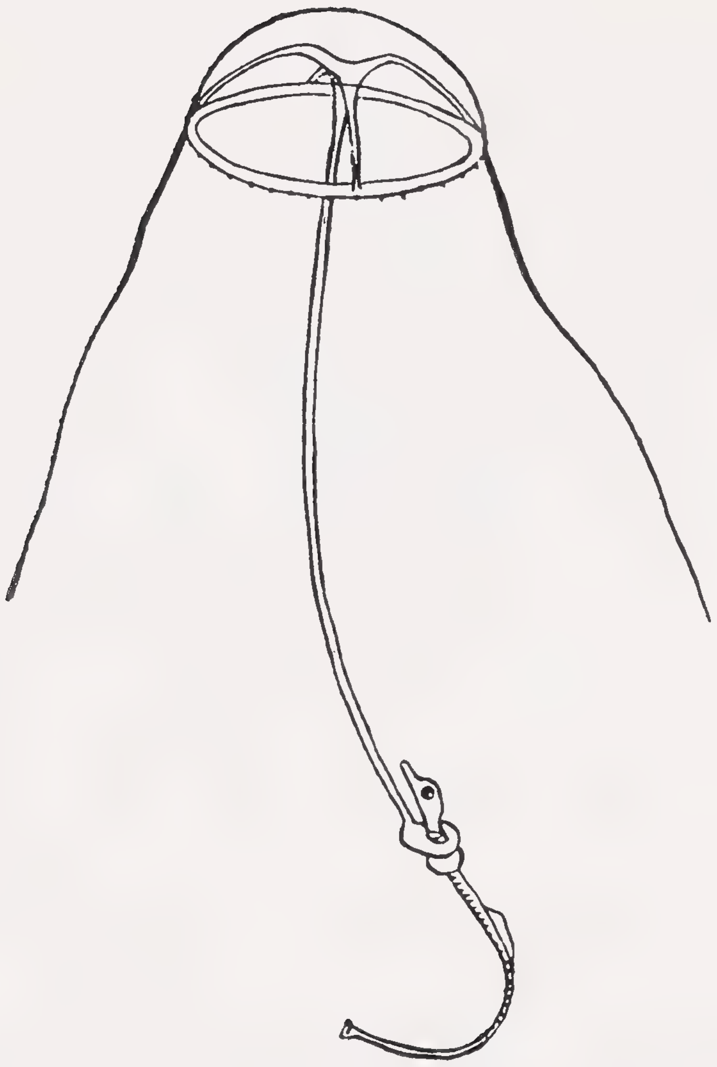


Figure 13. The graceful Saphenia with its prey. A pipefish is held by a double turn of the manubrium—a most unusual use of the bell-clapper. After Lebour, 1923.

with the manubrium, which was very flexible and seemed to be provided with stinging cells. The use of the manubrium as a lasso for little fishes is a most unusual one, never noted for any other medusa.

Steenstrupia rubra a Fisherman

The red medusa of Steenstrup (a well-known Danish naturalist) was never seen by Dr. Lebour to feed in the aquarium, but tow-net records show several full of fish-eggs, while two other contained young sand-eels and one a young clupeoid. Hence they are not merely general plankton-feeders but fish-eaters also. No figure was given.

The Voracious Turris pileata

The spotted turret- or mitre-shaped medusa is also a fish-catcher as Dr. Lebour's figure (No. 14 herein) shows. This particular specimen has a little sea-scorpion caught on a tentacle. By vigorous efforts, lasting ten minutes, the fish broke the tentacle off and ran away with it. The two cottids in the manubrium were not so fortunate. This turret-medusa is very voracious—it caught, ate, and digested (after several days) a young squid larger than itself.

Experiments in 1923 showed Dr. Lebour that *Turris pileata* is a dangerous medusa to keep in an aquarium since it is both omnivorous and extremely voracious. Two from the trawl for taking young fish contained little whitings longer than themselves. In Fig. 15, one of these medusae is shown stretched to a length of 25 mm. with the little whiting almost completely filling the stomach. Another contained a 17 mm. whiting. Of two others one contained a young cottid, the other a little dragonet.

Linuche unguiculata a Fish-killer

Next to be recorded as a fish-eater is that medusae noted by William Beebe in his "Beneath Tropic Seas" (N. Y., 1928, pp. 21-23) as thimble or finger-nail jelly. When brought in to the laboratory, "Not only did they paralyze and engulf some of the small fishes which I had been at pains to capture and unwisely place in the same compartment, but they somehow chose only the more succulent portions, rejecting the heads and tails." Next day when diving out on the reef in Port-au-Prince Bay, Haiti, Beebe saw

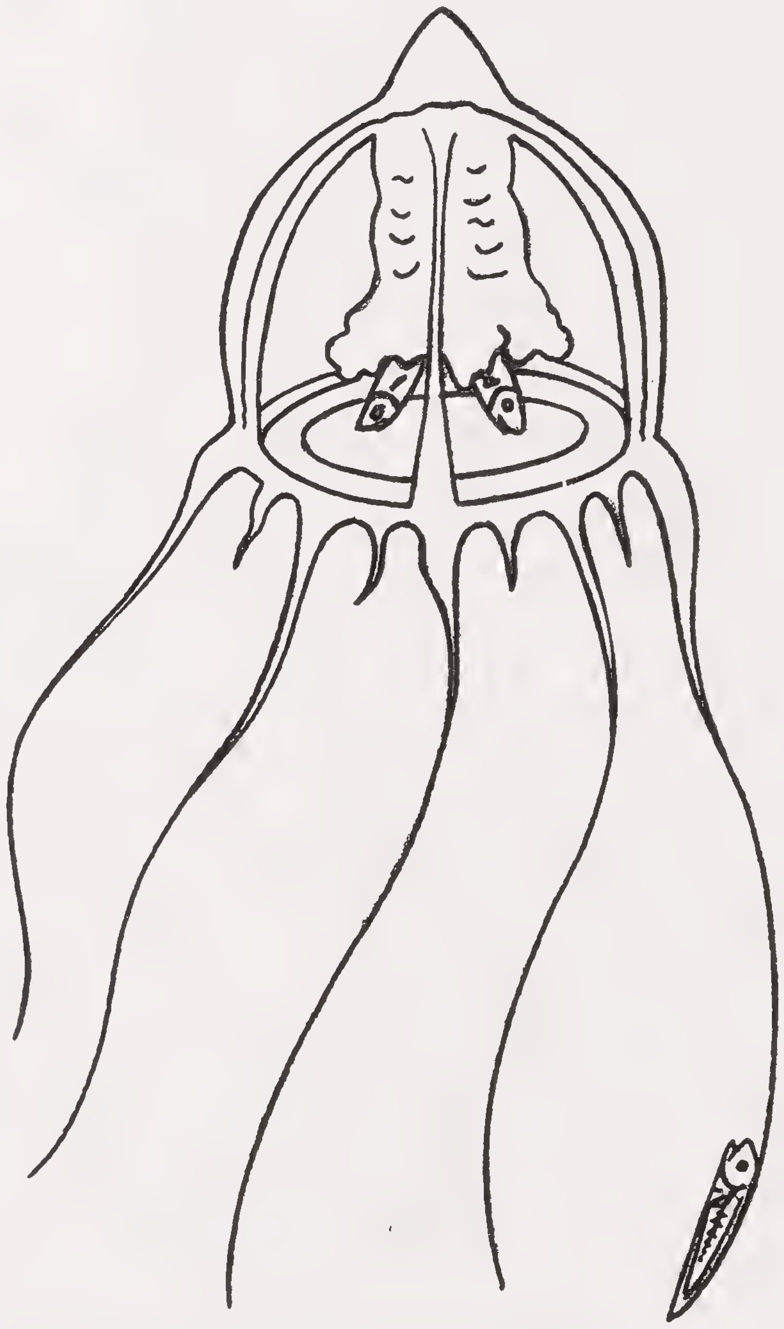


Figure 14. The Turret-Medusa a capturer of young fish. Two sea-scorpions are held in the mouth and another has just been snared by a tentacle. After Lebour, 1922.

thousands of these thimble-jellies and observed that in a number he could make out the outlines of the bodies of very small fishes.

Tamoya haplonema Catches Fishes

In Port-au-Prince Bay, Haiti, Beebe (*op. cit.*, pp. 85-86) found many medusae of this genus and species. These are akin to Charybdea, noted earlier, and have similar habits. They not only acted as hosts and protectors for small "Bumpers" (*Chloroscombrus chrysurus*) but fed on them as well. He saw live fishes within the jellies and he also "saw four of these fish which were killed by the nettle lariat, three of them already drawn well inside the mouth. The fourth I saw caught, and after a terrific struggle it managed to snap free, but sank dying in the water."

Tima formosa an Enemy of Fishes

For data on the fish-killing habits of this medusa, I am indebted to the courtesy of Dr. C. J. Fish. He writes that:

> In 1924, in Massachusetts Bay, at a time when the sand-eels were filling the waters with fry, *Tima formosa* was taken in almost every haul with from 2 to 3 sand-eels (ranging from 20 to 25 mm.) in the manubrium. These could not have been taken after the specimens were confined in the plankton bucket as in each instance the specimens were partly digested.

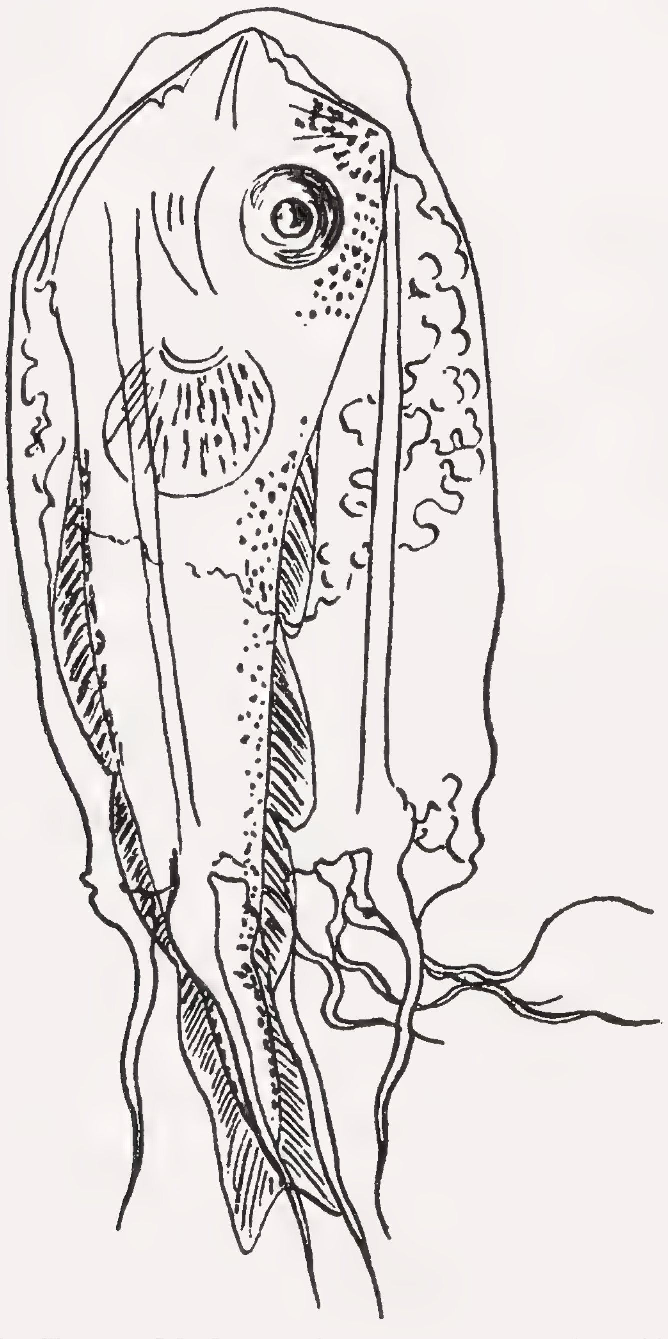


Figure 15. The Turret-Medusa with a young whiting. To accommodate a fish longer than itself, the medusa has narrowed and elongated its body. After Lebour, 1923.

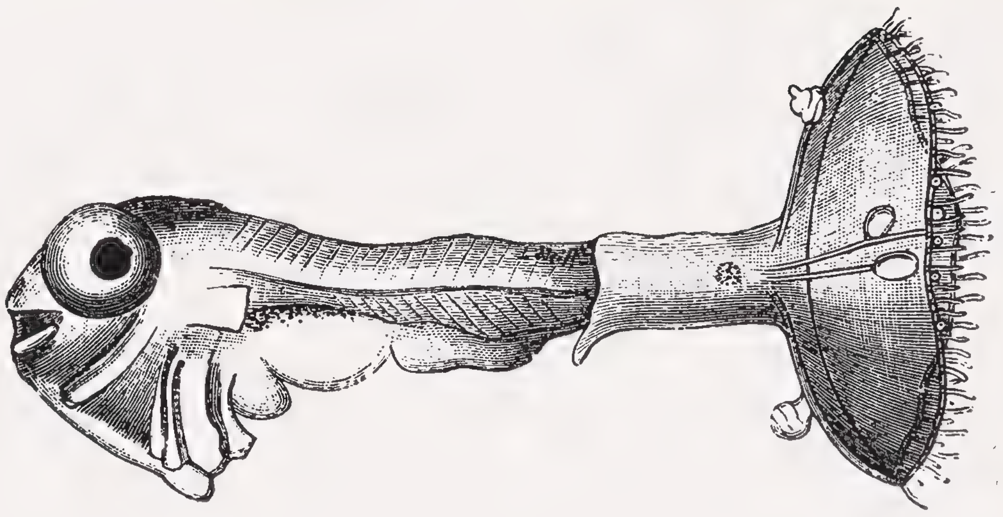


Figure 16. A Pleurobrachia endeavoring to engulf a little flounder and becoming everted in the process. After Masterman, 1897.

Pleurobrachia a Flounder-catcher

McIntosh and Masterman in their "Life-Histories of British Marine Food-Fishes" (London, 1897, p. 61, fig. 11) state that jellyfishes, particularly those of this genus, are very fond of post-larval fishes and thus play a part in keeping down their numbers. Illustrative of this is their Figure 11 (Figure 16 herein) showing this jellyfish endeavoring to ingest a deep-bodied baby flounder larger than itself. The struggles of the little fish have caused the jelly to become turned inside out, a thing possible because of the simple organization and marked distensibility of the coelenterate. The representation is a rather weird one, but its authenticity is attested by the fact that it was drawn by Masterman himself.

The Effect on the Fisheries of the Depredations of Medusae

Dr. A. G. Mayer in his "Medusae of the World" (1910) listed 737 species of Medusae (mainly marine). Of these forms, 27 are shown in this article to be fish-eaters, and presumably hundreds of others have like habits. In fact there is little reason to doubt that all of them may catch and eat small fishes. Then when one recalls the billions of Medusae large and small in the oceans one must believe, on the basis of the data set out above, that these animals play no small part in restricting the fish-food supply of mankind. Most of these abounding medusae are small but others are very large as Hargitt and Agassiz state. The great abundance of large medusae is well known to those who have been much about the sea.

Martinus Slabber, apparently the first man to see and describe a medusa in the act of catching a fish, was also the first to remark (1778) on the effect on man's food supply of the fishing habits of the jellyfishes. He comments upon the countless numbers of jellyfishes in the sea and then says:

> One here sees clearly that, however small the jellyfishes are, they are very harmful to the fishes since according to the increase in size of the jellyfish they catch larger fishes. By the great numbers of jellyfishes, which use the fish as food, an astonishing number of fishes must be swallowed as food as has been revealed by my observation of this small jellyfish.

The more or less occasional observations of various authorities quoted herein are cumulative in their evidence that medusae (mainly adults) feed freely on fishes. Then Dr. Lebour's careful experiments and observations of these habits in young medusae must convince the most skeptical that the innumerable hordes of jellyfishes, young and old in the sea must be responsible for a tremendous mortality in the young fish population therein. Then must be added the observations of Dr. Fish covering many years of work with vast collections of plankton. He states, with reference to three forms only, for which he had data immediately at hand wherewith to answer my inquiry, that Aurelia, Phialidium, and Tima "proved of very vital importance in depleting the flounder stock," in ravaging the hordes of young sand-eels, and in taking heavy toll of young clupeoids. Dr. Fish purposes, when time and opportunity permit, to bring together for publication his extensive first-hand observations covering many years on the fish-feeding habits of medusae. His paper will be awaited with much interest.

Much Data on Coelenterates

Starting out on this study with but few references, I have been surprised at the large number of records of Coelenterates as feeders on fishes. First were set off, as article I of this series, the doings of Hydras and Colonial Hydroids; and now, instead of including all the higher Coelenterates in a second paper, I have been forced to limit the story to the Medusae only. There is still left enough data on other animals of this great group to make one or more additional papers before the story is finished of "Coelenterates as Enemies of Fishes."

◆

Another Reservoir for the Aquarium: In July 1908, the Aquarium put into operation a reservoir holding 100,000 gallons of pure sea water brought by steamer from the Ocean. The marine exhibits of the institution could no longer be maintained in the brackish and polluted water pumped from the harbor. This stored sea water system has been in highly successful use ever since, losses due to foul water being eliminated.

The Aquarium will soon use a similar stored water system for its fresh water exhibits. For many years the fresh water supply drawn from the City system has been discolored during the winter months, although satisfactorily clear in summer. This turbidity is caused by a fine semi-colloidal suspension of clay that in no way interferes with the potability of the water. It does, however, seriously interfere with visibility and cannot be removed by any ordinary or practicable filtration because of the microscopic size of the particles.

A reservoir for the storage and control of the fresh water required for the Aquarium is now under construction by the Civil Works Administration, funds previously sought for this purpose not having been secured. Half of the living exhibits of the Aquarium represent forms of life inhabiting fresh waters. The presence of clear water in the tanks devoted to them will relieve the institution of a serious drawback. The entire system is being constructed of non-metallic materials which are much more satisfactory for such purposes. —*C.H.T.*

Air Transportation of Fishes: The interest in small tropical fresh-water fishes suitable for domestic aquaria continues to increase, and competition for new specimens is keen.

The planes of the Pan-American Airways, flying across South America, carry shipments of these fishes on every flight from Manous to Para, where the fish are conditioned for transportation to New York, the center of distribution.—*C.W.C.*

Some Notes on the Curious Behavior of Two Gymnotid Eels from South America:

Sternarchus albifrons (Linnaeus), from a tributary of the River Amazon, and *Gymnorhamphichthys hypostomus* Ellis, from a small stream near Para, Brazil, captured by Mr. Karl Griem and recently acquired from him by the New York Aquarium.

C. W. Coates

If any credence can be placed in the superstitions of South American Indians, a rather remarkable fish has recently arrived at the Aquarium from Brazil, bringing with it the spirit of some dead person or a personal devil, either or both of which are supposed to inhabit its body.

Although of wide distribution, ranging from the Orinoco in Venezuela to the Rios Paraguay and Parana in Brazil, and reaching more than one foot in length, it is seldom seen. Travelers interested in such matters inform us that they have not found more than four or five natives of the whole territory who have ever seen one. Scientific observations are equally sparse, for in spite of the somewhat extensive fishing in these waters by representatives of museums and similar institutions, only four had been recorded by 1923. Most of the local Indian tribesmen seem to know it, by reputation at least, and it has at least three Indian names. The Guianan version of these is "Cheeogaa," the Brazilian, "Tovira cavallo," and the Indians of the region near Cuyaba call it "Man tschiogaa."

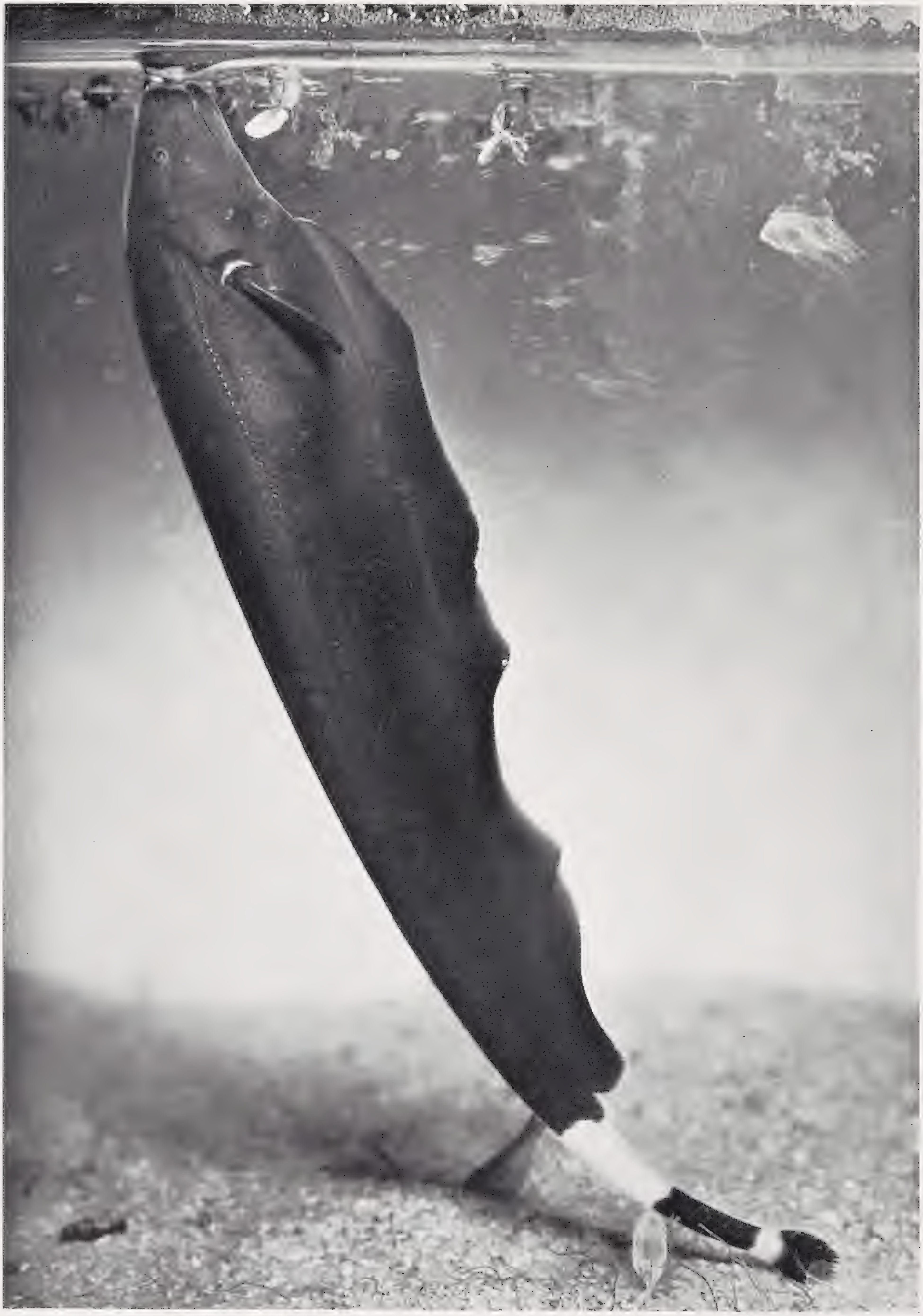
The fish is of a lovely velvety blackness with a light-colored line running from the mouth over the top of the head and along the back to almost half-way down its body. Two broad bands of a similar light color completely encircle the body near the tail, the one nearest the tail being the narrowest. These bands and the stripe are recorded as ranging from rose-pink to red. In the specimen received at the Aquarium they are all pale gold. Records also give the eye color as bright red, turning to bright china-blue in preservative, but the color of the eye of our specimen is jet black and it is almost impossible to distinguish where the eye is, so similar is it in color to the skin of the animal.

The shape of the fish is graceful, as are all its movements. Roughly eel-shaped, there is a broad anal fin extending from just below the head to the tail. This fin is quite black except where it is crossed by the two bands referred to previously. The pectoral fins—large and well-rounded—are also jet black.

The whole appearance of the animal is very attractive, and there is nothing about the fish which would indicate any traffic with the nether regions, unless it is the fact that the creature habitually swims on its back or side, or "stands" for hours motionless, on its tail, or swims with equal facility backwards or forwards. It is unlikely, however, that even these peculiarities can be the cause of its unsavory reputation if we are to believe in its extreme rarity, for in the few times it has been viewed by natives, and the four or five times captured or killed by scientists, such odd positions of rest and locomotion would scarcely be observed. At least they are not mentioned anywhere. There is also no mention of the fish ever having been exhibited alive before.

With the *Stenarchus,* Mr. Griem brought back to us several specimens of *Gymnorhamphichthys hypostomus* Ellis. These fish were between four and a half and six inches long, and were taken in a small forest stream in the vicinity of Para, Brazil. They were translucent; almost transparent. So much so, in fact, that the vertebral column was clearly seen. A fine black line ran from behind the head to the tail parallel with the backbone, and about half-way between it and the lower margin of the body. Another broader line ran almost along this edge, and the two lines were connected by a series of fine striations about one-eighth of an inch apart. These lines are not visible in alcoholic specimens.

As with all the members of this family (Gymnotidae) the head and intestines are situated closely together and are not longer than about one-fifth of the total body length. The anal fin, which is also transparent, is broad—almost as



Stenarchus albifrons. The position, with the nose not quite touching the surface of the water, is characteristic. The head of *Gymnorhamphichthys hypostomus,* sticking out of the sand, is just visible to the left of the upper band on the tail of *Sternarchus.* Photo by S. C. Dunton.

broad as the body in parts—and extends from just below the head to about one inch from the tail proper. This fin is in constant motion whether the animal is swimming or not.

The fish spent all the daylight hours buried in the sand at the bottom of the aquarium, only coming out into free water at dusk. Our observations tally with Mr. Griem in this, that the fish makes its first appearance above the sand at about seven o'clock in the evening, whether or not an artificial light was kept burning continually. If the sand was raked over, the fish might be driven out into the water, but it would immediately arch its "neck," and with the body held stiffly and the anal fin vibrating rapidly, make little rushes at the sand at the bottom of the tank. For some reason one spot was preferable to another although the sand was of the same texture and looseness, as far as we could judge. After several gentle dives at the sand, during which the nose of the fish would enter the sand perhaps a quarter of an inch and then be withdrawn, the fish would dive into the sand with the utmost ease and rapidity, wriggling forward until the last vestige of the slender tail had disappeared. Not always, but frequently, the nose of the creature would reappear, sticking out about one-eighth of an inch above the sand where it would remain all day unless disturbed. When the nose was visible the eyes of the fish might also be observed. From the movements of these, the fish seemed to be taking a deep interest in what was transpiring.

As many as fifteen different attempts to find some suitable spot in which to burrow were observed. If the fish was disturbed near the tail, it would first of all try to wriggle under the surface of the sand out of reach, but if the disturbance was persistent the fish would suddenly appear and after swimming about the tank for a few seconds, would go below again. If the disturbance took place near the head of the fish, it would reappear tail first. On no occasion was the fish observed above the sand of its own volition while it was light, except when it was ill and about to die. However, fish kept in a dark tank would sometimes be found swimming above the sand, only to disappear immediately a light was turned on. This was during the daytime. A light turned on at night was apparently unnoticed, the fish proceeding with their meals of small worms quite indifferently.

All of the fish we received died after a short while for reasons we were unable to identify, for the water in which they were kept was the water in which they were captured, and the sand was brought from their own streams. The food, Tubifex worms, were also the same as they apparently were in the habit of catching, and the manner of demise was the same in each case. The fish would be observed above the sand for increasing periods during the day and the next morning be found dead.

◆

Black Tail of Trout and Salmon

Ross F. Nigrelli

MOST of us are familiar with the ability of certain fishes to change their color. Functionally, this reaction is due to the contraction and expansion of pigment cells (chromatophores[1]) which are under the control of the sympathetic nerves. Thus, if a flounder is placed in a tank with a white background, all of the black pigment cells will immediately contract and the fish will appear pale. If the fish is placed in a tank with a black background, the cells will expand and the fish will take on a darker color. When placed in a tank with a black and white bottom, the fish will tend to assume this black and white coloration by expanding certain groups of cells and contracting others. It is interesting to note that the above reaction depends entirely on vision. A blind fish cannot vary its color with the environment.

For the past several years trout and salmon hatched and reared in the Aquarium have shown a condition in which the black pigment cells (melanophores) of the tail region become more or less permanently expanded. As a result about 25% of the fishes that have been successfully reared appear with a "black tail." This abnormal coloration first makes its appearance in 5-6 month old fingerlings, and in fully grown trout one-fourth to one-half of the body is thus affected. In year-old salmon it extends forward, midway from the tail fin and the posterior border of the dorsal fin.

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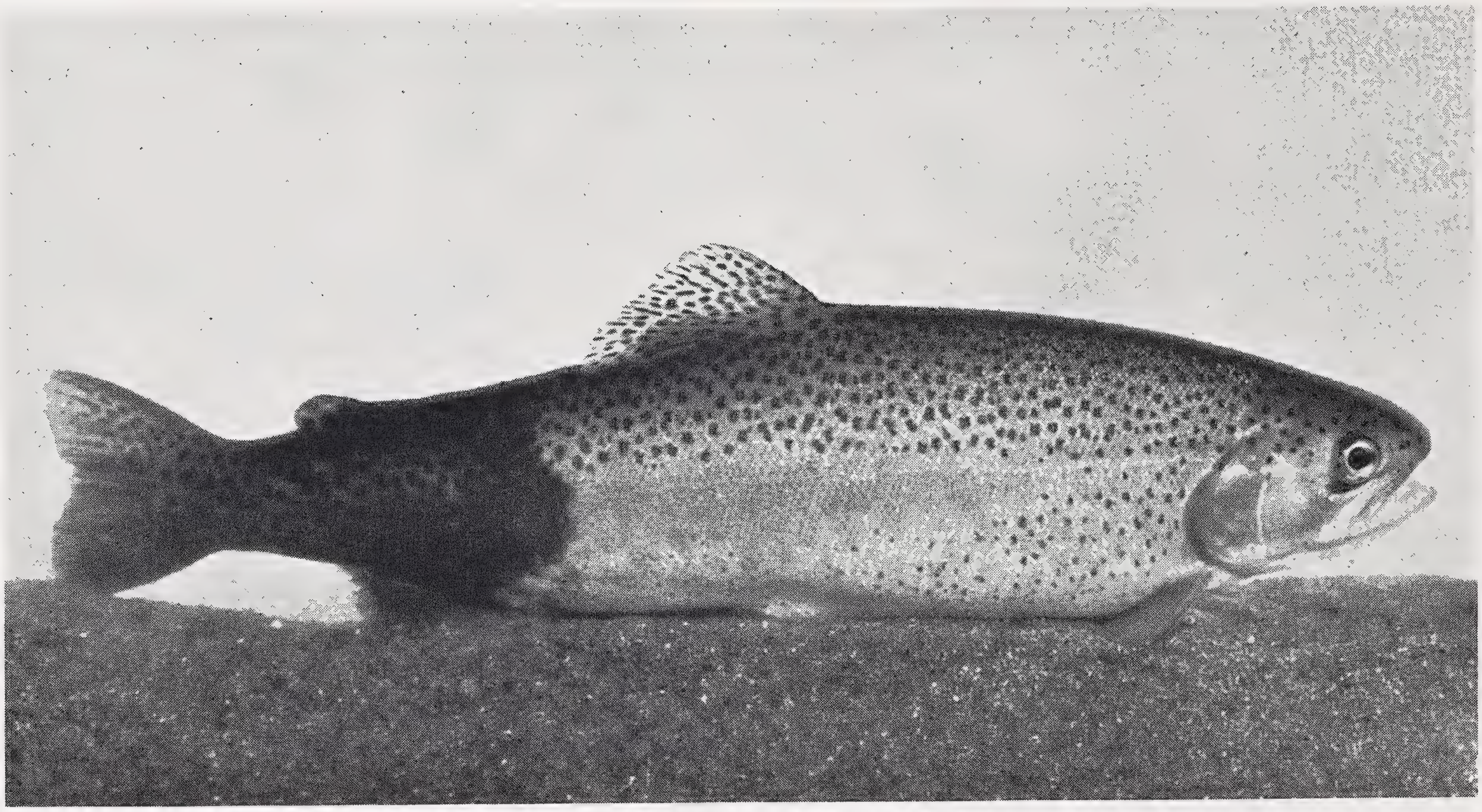
[1] Nerves which control organs that function unconsciously.



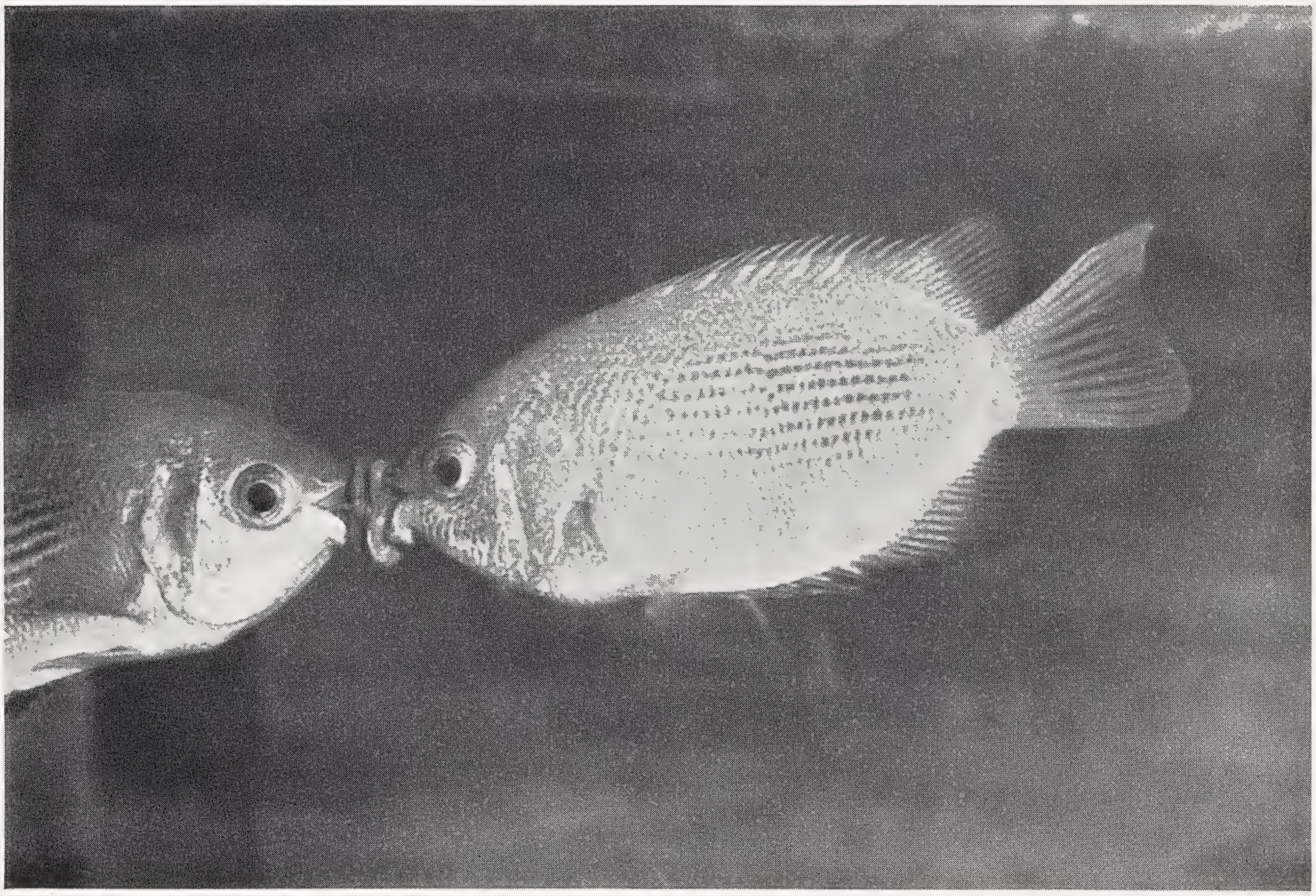
A rainbow trout (*Salmo irideus*) hatched and reared in the Aquarium, showing a typical "black tail." This fish is about twelve inches long and two years old, and is normal in other respects. Photo by S. C. Dunton.

Preliminary observations as to the nature of this condition have shown the following: (1) that an injection of a small dose (0.1 cc.) of adrenalin, or the application of the drug directly on the affected area, will cause a contraction; (2) placing the fishes with the black tail in a tank with a white background does not cause a contraction of these pigment cells, but those of the trunk and head readily contract; (3) placing them in a tank with a black background will cause all of the black pigment cells to expand, but the black tail can still be distinguished. Because of such reaction it was thought that the condition might be one of melanosis or overproduction of pigment cells, but a comparative count of the pigment cells in an area about 1 mm. sq., in both black-tail and the tail of a normal fish, showed very little difference in the number and size of cells. (4) All of the black pigment cells will contract on the death of the fish.

The black-tail of the Aquarium fishes must not be mistaken for a somewhat similar condition associated with a disease known to the German investigators as "staggers," which is caused by a specific parasite. Primarily, this parasite affects the organ of equilibrium, resulting in peculiar gyrations; secondarily, it becomes localized in the tail and forms nodules which press on the sympathetic nerve fibers that control the pigment cells in this region. This results in the appearance of a black-tailed condition. But in this case the nerves controlling the muscles are also affected, so that eventually the tail atrophies, invariably causing the death of the fish.

Examinations for such an infection in Aquarium fishes affected with the black tail gave negative results. These specimens are normal in their behavior, and some of the adult trout, weighing about three pounds, still show the condition. Mr. H. Dixon, of the Aquarium staff, who has observed this phenomenon for a number of years, claims that some of the fishes have reverted to the normal pigmentation.

From the above analysis, it may be concluded that the black tail of the trout and salmon in the New York Aquarium is due to a more or less permanent paralysis of the nerves controlling the posterior pigment cells. The basic cause of the paralysis has not yet been determined. At this writing its determination represents one of the innumerable problems that concern those charged with the maintenance of a satisfactory collection of living fishes.



The "kiss" of the Kissing Gourami. The enlarged lips are contracted and not visible except at this time. Photo by S. C. Dunton.

White Kissing Gourami

C. W. Coates

A PAIR of Kissing Gourami, *Helostoma temmincki* Cuvier and Valenciennes were recived by this institution in exchange with Rotterdam Aquarium. One pair of this species had already been received from the same source—a large, full-grown pair which had been on exhibition in Rotterdam for three or four years before their transfer to New York. This first pair, which antedated the arrival of specimens of the species commercially, achieved world-wide notice through motion pictures which were taken of the curious "kissing" indulged in by the fish. However, the first pair were of the type coloration of the species, a sort of brassy green-brown with darker lateral stripes throughout the body. The second pair are a very pale pinkish white, which changes according to the angle at which they are viewed, into a greenish, yellowish, or brownish silver. The actual colors are quite pale, and the fish well deserves the designation of "white."

Other than this pair, there are no records of any fish of the species of this color ever being exhibited, or, indeed, caught, and we are indebted to Dr. Kuiper, Director of the Rotterdam Aquarium, for his generosity in allowing us to acquire such rare specimens.

The "Kiss," which is such a curious development in fish behavior, is performed when both fish extend the lips of the sharp, slightly superior mouth into broad rings, and both fish swim or hover in the water with their lips in close contact for a considerable period. This may last as long as twenty-five minutes, or just a few seconds, but the longer periods are more usual. For periods of several weeks no kissing may be observed, while at other times the fish may be in juxtoposition several times a day.

The biological significance, if any, is not understood, but observation indicates some reproductive connection, for the larger of the two which is the male, apparently, may be seen during the times when the "kissing" takes place, to be driving the other which usually tries to swim out of the way. When the larger approaches too closely, the smaller turns to face it and extends the lips in the characteristic gesture. If the larger touches the lips, either a "kiss" or a turning away takes place, but if the smaller does not turn in time and extend her lips, she will suffer a severe bite. Younger specimens under observation seem to bear out the idea of courting activity, or at least sex recognition, for when the same driving takes place between two males of different sizes, the "kiss," when made in time, is of the briefest duration and is immediately followed by an attack by the larger.

These white specimens, which have a little color as has been noted, and dark blue or black eyes, are not pure albinos in the accepted sense of the word and are the third species of Labyrinth fishes to come to notice as developing light strains. The first was the "Betta Cambodia," a pinkish white strain of the popular and colorful *Betta splendens*. This strain, either naturally or through too much cross-mating with colored members of the species, does not breed true but throws off large proportions of variously colored fish in each brood[1]. Usually, too, some if not all of the fins are tinted, sometimes richly. The second species of the family to develop white strains was *Macropodus opercularis,* the attractive Paradise Fish of Southern China. A few specimens of these White Paradise Fish are undoubtedly albinos, for the eye is pink, and apart from a slight flesh-pink tinge throughout the body, the fish is colorless. However, the vast majority of the White Paradise are by far not complete albinos, for they display slightly shaded bands across the body, in place of the characteristic red or blue lines of the ordinary fish, and a dark blue or black eye, as in the White Kissing Gourami.

◆

African Fishes: Through the courtesy of the American-South African Line, a regular exchange system of fishes has been built up between the East London Aquarium, South Africa, and this institution. The fishes are transported by Mr. A. M. Vida, radio operator of the M/s *City of New York,* with the aid and cooperation of Captain George M. Wauchope and Chief Officer Paul S. Maguire.

Many valuable and rare specimens have arrived safely in New York on this modern fast liner, including zebrafish *Pterois volitans;* lungfish *Protopterus annectens;* mudspringer *Periophthalmus koelreuteri,* and blackfooted penguins *Spheniscus demersus.* In return the New York Aquarium has sent specimens of local and West Indian fishes which are highly valued in South Africa.

The officers of the ship capture fishes, in addition to those exchanged, and the Aquarium collection has been enriched by many spectacular and otherwise unobtainable specimens from the Island of St. Helena, Durban, South Africa, Portuguese East Africa and the Pungue River.

The ship has been equipped by the Aquarium with a number of tanks of different sizes, and an air pump. Most of the tanks are arranged around the back of the radio room. Here they are under the constant supervision of Mr. Vida, who is most active in the care of the creatures.

—*C. W. C.*

Amazon Fishes: The Aquarium received one specimen of Pirarucu, *Arapaima gigas,* from Marajo Island, Brazil, during February, 1934. This fish, which was a little over two feet long, was the sole survivor of five which were sent here; the other four, unfortunately, dying of cold in the harbor before they could be removed from the ship.

The specimen which arrived alive seemed to take kindly to its aquarium. It showed an intense interest in its surroundings, rather unusual in fishes, and was particularly interested in the flame of a match near the glass of the aquarium, following the flame about as it was moved. We were in hopes of keeping it alive until it reached full size—about fifteen feet long—but the fish did not live for more than one month, dying probably from the delayed effects of the severe chill it received on the ship. The body has been mounted and is now on display in the American Museum of Natural History.

The exportation from Brazil of this species is prohibited, but we hope to receive one or two more specimens in the near future, through the courtesy of the Governor of the State of Para, and to be able to keep them on exhibition until they have achieved full size.

—*C. W. C.*

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[1] This finding is based on numerous broods of the fish in this institution and is contradictory to that of Goodrich and Mercer, (Science 79 (2049): 318, April 6, 1934) who state that Cambodia always breed true.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

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Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

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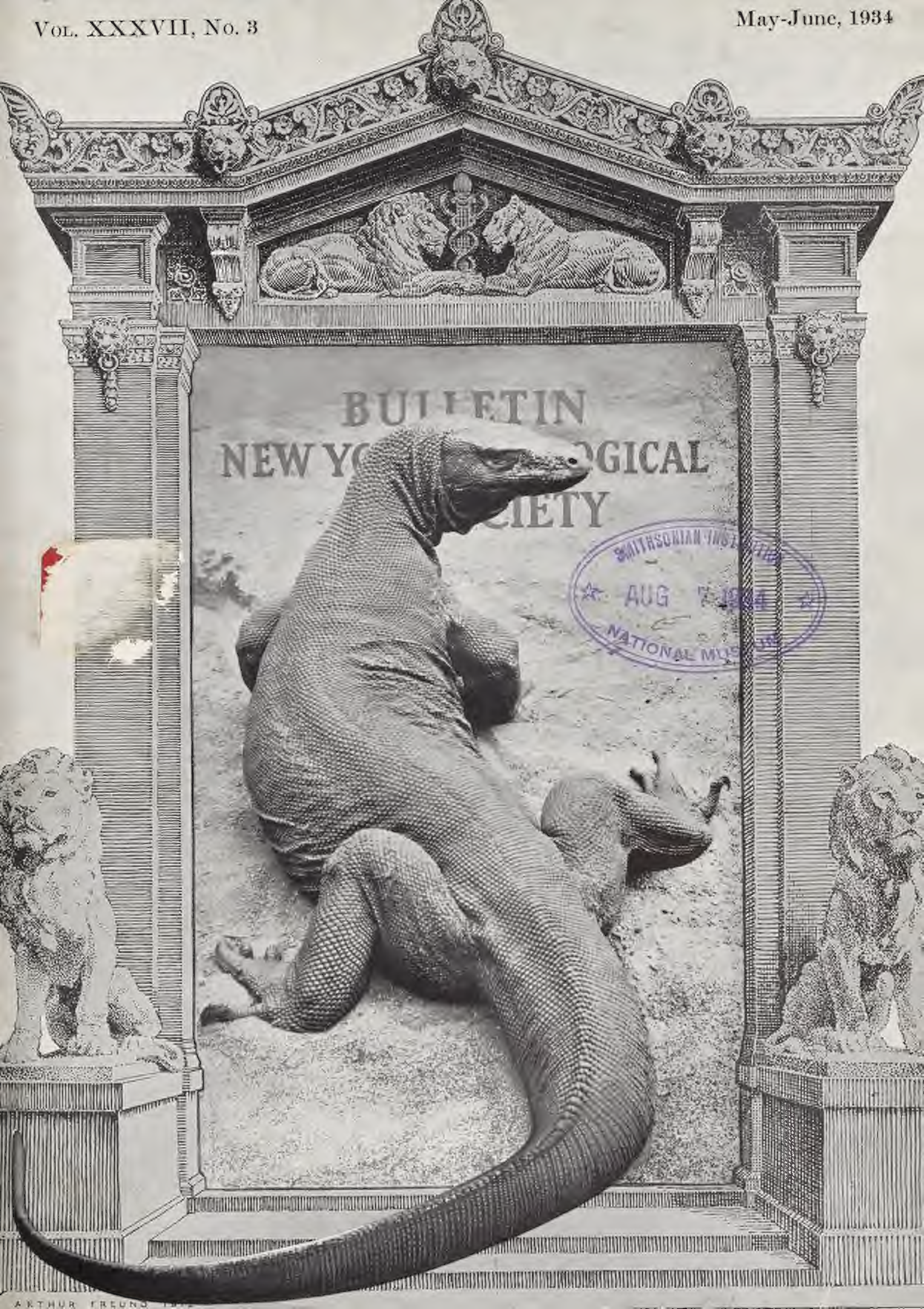

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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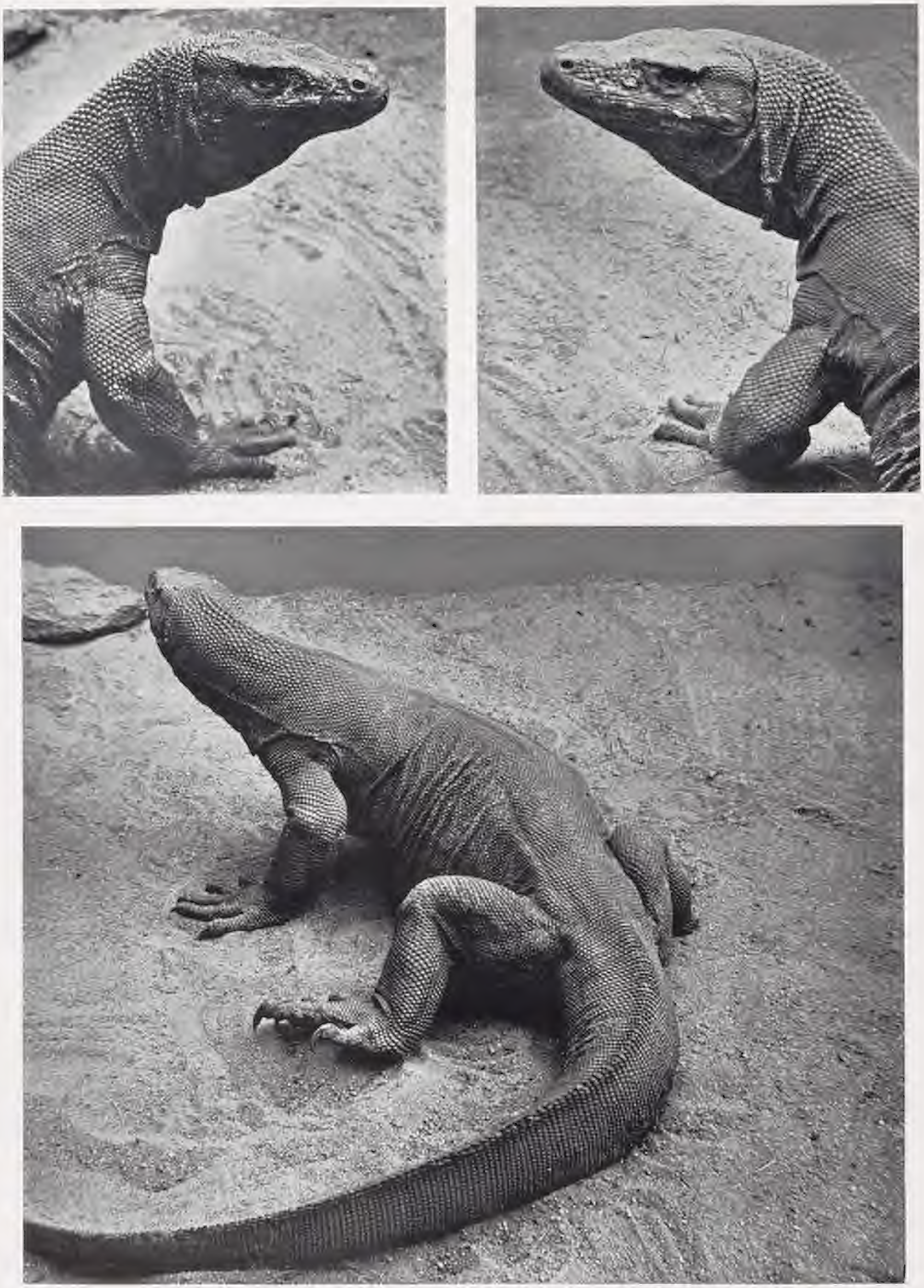

Giant Monitors, *Varanus komodoensis* in the Zoological Park. The specimen now on exhibition is a trifle over eight feet in length. Photographs by Elwin R. Sanborn.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY
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The Giant Monitors of Komodo

RAYMOND L. DITMARS
Curator of Mammals and Reptiles, New York Zoological Park

ON May 12, 1934, three Giant Monitors, *Varanus komodoensis,* arrived at the Zoological Park. They were captured on the small island of Komodo in the Dutch East Indies, during an expedition conducted by Lawrence T. K. Griswold and William H. Harkness. This is the second time that these "dragon" lizards, as they are popularly called, have been exhibited in the Park. The first occasion was in 1926, when two were delivered by the Douglas Burden Expedition. The first specimens lived only forty days.

The Komodo Monitor was unknown to science until 1914, when this enormous lizard was named by Major P. A. Ouwens, late Director of the Buitenzorg Museum in Java. It was thought for quite some time that a giant lizard of some sort inhabited Komodo Island and possibly the small islands to the west of Flores. The two mentioned expeditions found ample proof as to the abundance of lizards up to fully twelve feet in length, massive in build and attaining the weight of two hundred and fifty pounds or more—a relatively great weight for a lizard.

The natives of the islands had long feared this savage meat-eating creature, that was capable of dragging off wild pigs bodily. The "dragons" were numerous on Komodo Island, which is hilly—and rocky—in parts. They were attracted to box traps baited with wild swine. The dead swine were easily torn to pieces and gulped down.

The Griswold-Harkness Expedition obtained a permit from the Dutch Government to capture a restricted number of specimens, as the Dutch officials have taken strict measures to prevent extermination of the remarkable reptiles. Eight monitors were caught by means of a large, wooden trap. Four were deposited in the Soerabaja Zoological Gardens in Java, and four were taken out of the country. One died during the sea journey to the United States, and another died shortly after arrival in New York. A third was sent to the National Zoological Park at Washington, D. C., and the fourth remains at the New York Zoological Park.

The example on exhibition here is slightly over eight feet long. It is housed in the easterly portion of the Reptile House and has access to indoor and outdoor enclosures. The exhibition quarters have specially constructed platforms and water tanks. Apparently in fine condition, the reptile is fed about every five days, an alternate diet consisting of twelve eggs, two pigeons or a moderate size chicken. The spectacular creature can be seen by the public from both indoors and outside.

The monitors, family *Varanidae,* to which the "dragon" lizard belongs, contains a single genus made up of twenty-seven species. The distribution covers Africa, India, Malaysia and Australia. Among the members are the largest and heaviest known lizards. They are flesh-eating and voracious, and in a wild state vary their diet with the eggs of the larger birds, and some species dig up the eggs of crocodiles. The most characteristic feature of the genus is the extremely long, deeply forked tongue. In proportion to the size of the head, the tongue is much longer than that of snakes. As a monitor progresses, the tongue is kept constantly darting in evident investigation of nearby objects. Another striking peculiarity is the long neck. On this the head may be drawn back to a considerable extent, enabling the powerful reptile to make a quick dart in capturing prey. The tail is long and heavy. Among the desert species it is round, while others have a compressed tail and are excellent swimmers.

The largest known species inhabits Komodo Island. Next in size is the Indian Monitor, or Kabara-goya, *Varanus salvator,* of easterly Asia and the larger islands of Malaysia. It reaches a length of nine feet, is active and powerful, but of relatively much lighter build than the Komodo species. The Desert Monitor of Africa and southwesterly Asia is much smaller in size.

The feeding habits of the monitors are rather characteristic. The prey is seized in the strong jaws and violently shaken, then quickly swallowed, without mastication. Eggs are delicately manipulated to be dropped down the throat without breaking the shell. Kept indoors, monitors are rather docile and can be approached without difficulty. When allowed to remain out of doors in the air and sunlight, a peculiar mental change takes place and they become savage and wild. When returned to inside cages, they soon quiet down, although high temperature, required by all the species, is steadily maintained.

Whence Came The "Dragons of Komodo"?

William King Gregory

Fellow of the New York Zoological Society

At the first sight the famous "Dragons of Komodo," one of which is now on exhibition in the New York Zoological Park, may prove to be somewhat of a disappointment to the average visitor, whose ideas of dragons are apt to be colored by the fearsome monsters embroidered on Chinese screens. Indeed, the cynic, viewing this rather sluggish saurian for the first time may well suspect that these imposing reptiles may owe a good part of their fame to the enterprising journalist, whoever he may be, who landed his story of the Komodo lizards on the front page by the simple device of labelling them "dragons," hinting also that they might be the original of the Chinese dragon.

But the typical Chinese dragons are essentially four-footed serpents, garnished with horrendous accessories often including the clawed feet of an eagle and a malevolent devil-mask face, with horns. The poor Komodo lizards, on the contrary, are plump-bodied, sprawling things, with a vacant stare and a face devoid of evil embellishments, except of course the forked tongue.

The mysterious power of poisonous snakes to strike and instill swift-coming death into man or beast has often been regarded by the credulous

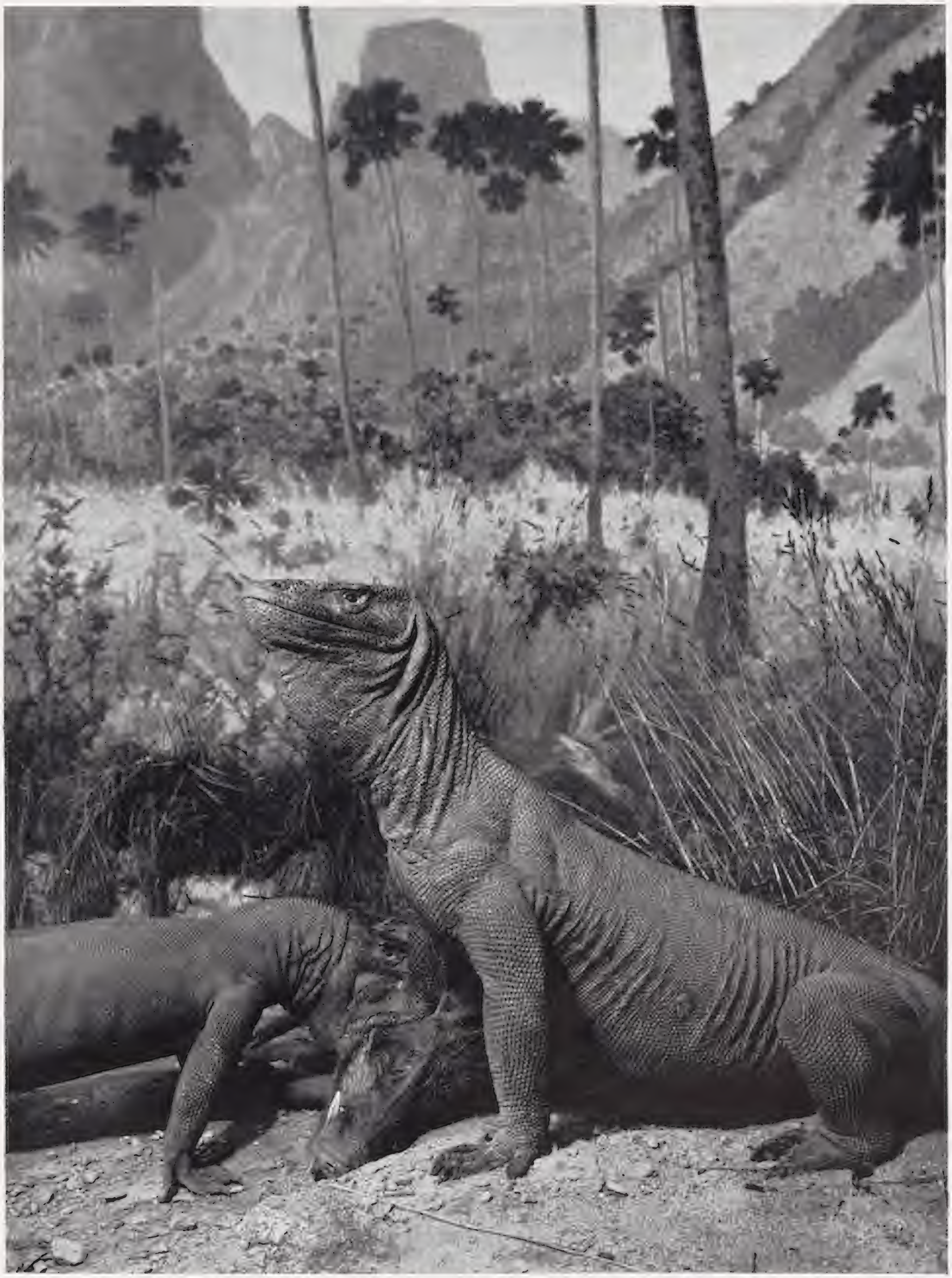


Fig. 1. The Dragons of Komodo "at home." Mounted group from the Douglas Burden expedition, in the American Museum of Natural History.

mind of *Homo sapiens* as a valid claim for the divinity of the death-dealers. But the carvings on the temples of the snake-gods, from Central America to Cambodia, apparently lend no support to the suggestion that any of the images of these deities could have been based directly or indirectly upon the Komodo lizards. However, the latter might plausibly claim a real cousinship to the dragon of St. George, since the mediaeval artists who created this reptile were probably familiar with the common lizards of Europe. The good old German dragon of Siegfried belongs to the same family, but is instantly distinguishable by his ultra bass voice and fire-spitting habits.

Another ingenious reporter started the rumor that some scientists are inclined to regard the Komodo dragons as the lineal descendants of the dinosaurs of past ages. This rumor may persist in spite of the fact that if we consider the family tree of reptilian life as a whole we see that the Komodo lizards represent only particular twigs of the great lizard group and that the nearest relatives of the lizards are not the dinosaurs but the snakes. The dinosaurs, on the other hand, sprang from a very different section of the tree and in order to find the common ancestors of lizards and dinosaurs one would have to seek far down the main stem of reptilian life.

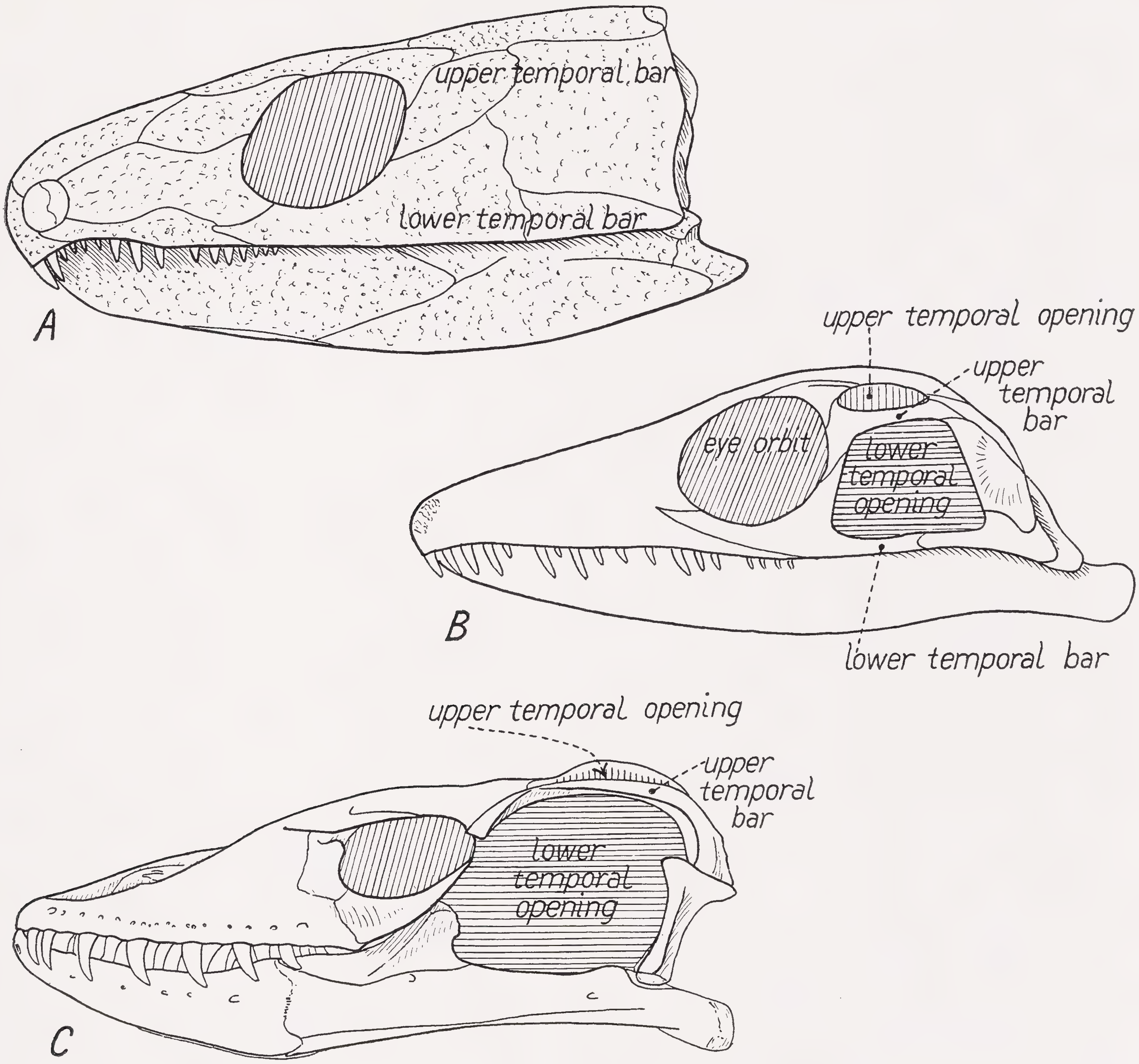
The query, "Whence came the dragon lizards of Komodo?" can be most conveniently answered, it seems, by a brief summary of some pertinent findings of palaeontology and other branches of science that throw light upon the history of the reptiles.

The origin of the first filterable virus is probably an affair of two billion years ago; the origin of the vertebrates would be of the order of magnitude of half a billion years; that of land-living amphibians in Lower Devonian times is estimated at 330 million years. At any rate we now have actual fossil amphibians from the Upper Devonian of Greenland which represent an early stage in the adaptation of air-breathing fishes for life on land. The earliest known reptiles, dating about 250 million years ago, from the Upper Carboniferous of Pennsylvania, Ohio, Texas, France and Czechoslovakia, were lizard-like in general appearance; but in the temporal region of their skulls there was a continuous shell of bone covering the jaw muscles, a part of the "bony facial mask" of their fish ancestors. Some millions of years later, in the Permian age, the reptiles had already become considerably diversified.

In the remote ancestors of the mammal-like reptiles, a single round hole had been developed in the bony mask of each cheek, above the jaw muscles; but in the common ancestors of the lizards, dinosaurs and other groups, two such round openings, one above the other, had appeared. These upper and lower fenestrae, or windows, were separated from each other by horizontal strips of bone, called respectively the upper and lower temporal bars. In the lines leading to the varied dinosaurs both the upper and lower temporal fenestrae and their accompanying bars were retained; in the ancestors of the lizards, however, the lower temporal bar gradually became absorbed, leaving intact the upper part of the lower temporal opening, the upper temporal bar and the upper temporal opening. Such is the arrangement preserved to this day by lizards in general, including those of Komodo (page 71).

True lizards date back to the Upper Triassic period and are thus contemporaneous with the oldest known dinosaurs. During the later part of the Age of Reptiles, especially during the Upper Cretaceous period, beginning one hundred million years ago, the order Squamata, which includes the lizards and snakes, enjoyed a great "adaptive radiation" (pg. 80). The remote ancestors of the varanoid or monitor lizard group gave off in one direction an amphibious branch which finally culminated in the mosasaurs or true sea lizards of the Upper Cretaceous of Kansas, New Jersey, France, New Zealand and many other parts of the world. In the opposite direction, the lizard ancestors of the snakes gradually reduced their legs, even to the point of complete disappearance and at the same time absorbed both the upper and lower temporal bars of their skulls. Meanwhile the central monitor stock persisted to give rise to the recent and fossil monitor lizards of Africa, India, the Malayan region and Australia. Of these the Komodo lizards are most closely related to recent and extinct monitors of Australia.

The visitor to the Australian Museum in Sydney, New South Wales, may see in a certain



Comparative figures of skulls of (A) stem reptile, *Captorhinus* (after Broom); (B) primitive two-arched reptile, *Youngina* (after Broom); (C) *Varanus komodoensis* (original).

glass case some precious relics of *Varanus* (*Megalania*) *priscus* (Owen), one of the extinct Australian relatives of the Komodo lizards. These animals, according to Professor Emmet Reid Dunn[1], may have measured about fifteen feet in length as compared with nine feet six inches in the type of *Varanus komodoensis.* The vertebrae have extremely small tunnels for the spinal cord; the centra or bases of the vertebrae were excessively wide in proportion to their length. According to Professor Dunn's measurements the vertebrae of the Komodo lizards were intermediate between the relatively narrow vertebrae of more primitive monitors and the excessively wide vertebrae of *Varanus* (*Megalania*) *priscus* (see pages 72 and 73).

Professor Dunn's careful studies of various parts of the skeleton of recent and extinct monitors afford strong evidence for his conclusion that the Komodo lizards have been derived from Australia. But how and when did their ancestors arrive in their present homes (Komodo, Flores, and adjacent islands)? Precise answers to this question may never be given but the general

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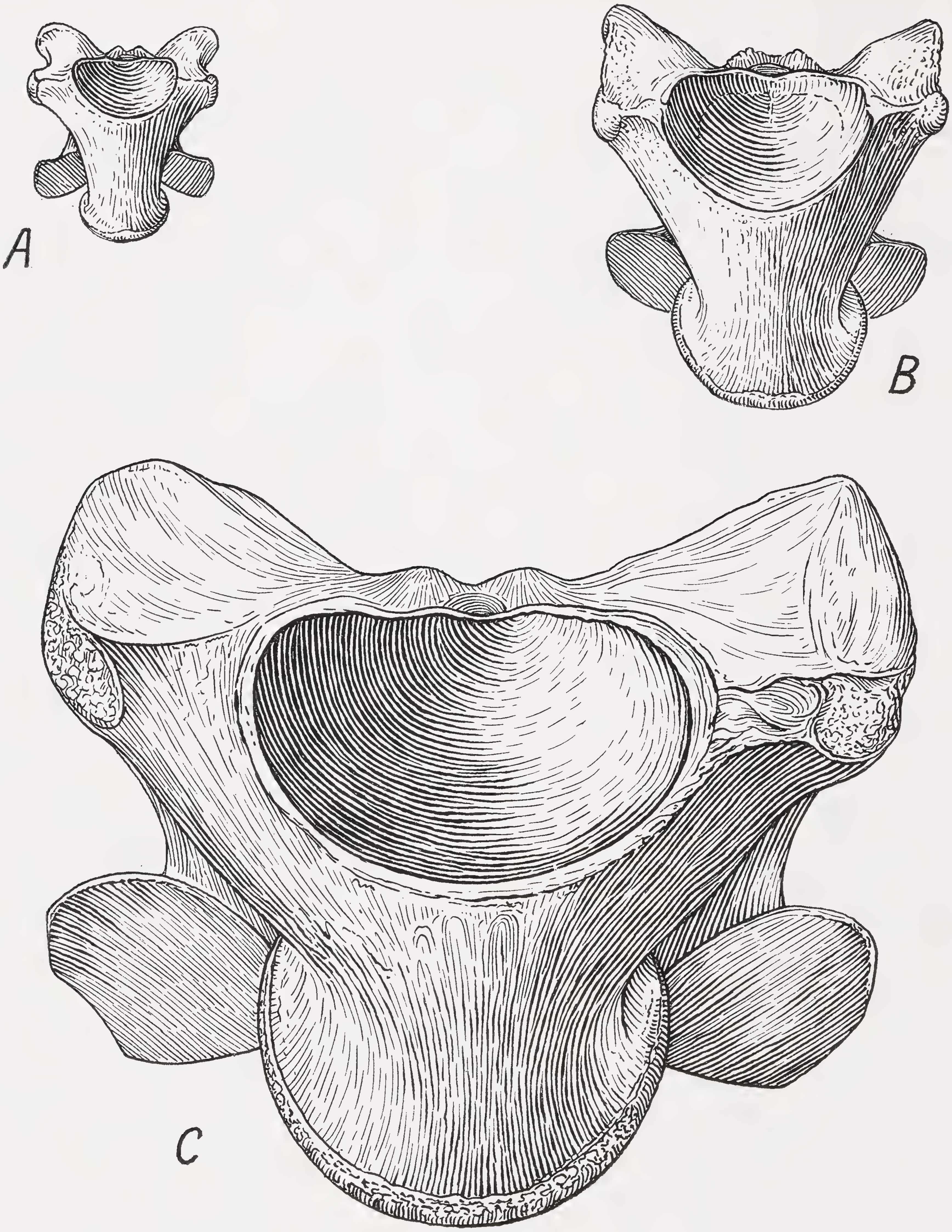
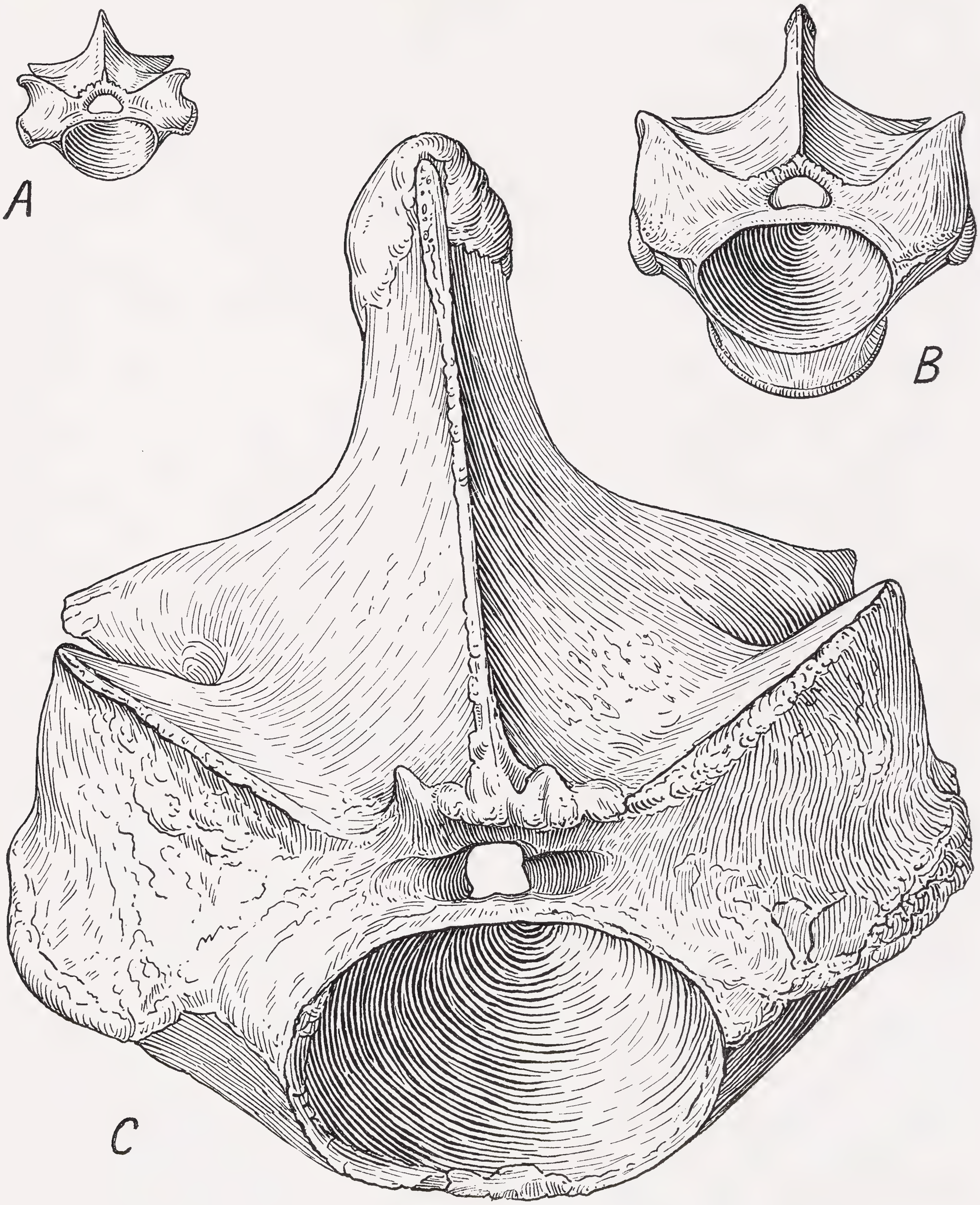
[1] Results of The Douglas Burden Exposition to the Island of Komodo. I.—Notes on *Varanus komodoensis.* American Museum Novitates, No. 286, Sept. 30, 1927, pp. 1-9.



Vertebrae of (A) ordinary monitor; (B) Komodo "dragon"; (C) giant fossil monitor (*Varanus priscus*) of Australia, under side, natural size. (C, after Owen; A, B, from originals.)

geological and zoological history of southeastern Asia and Australia has been the subject of many fruitful investigations tending to show that the case of the Komodo lizards which find their nearest existing relatives in Australia is by no means unique.

The total herpetological collections of the Douglas Burden Expedition to the Island of Komodo described by Professor Dunn numbered 1616 specimens, including seventy-three species and six sub-species. In his reports on the lizards, snakes and frogs of the East Indies, Professor Dunn was able to show (1927, p.7) that in each group there was a very large modern

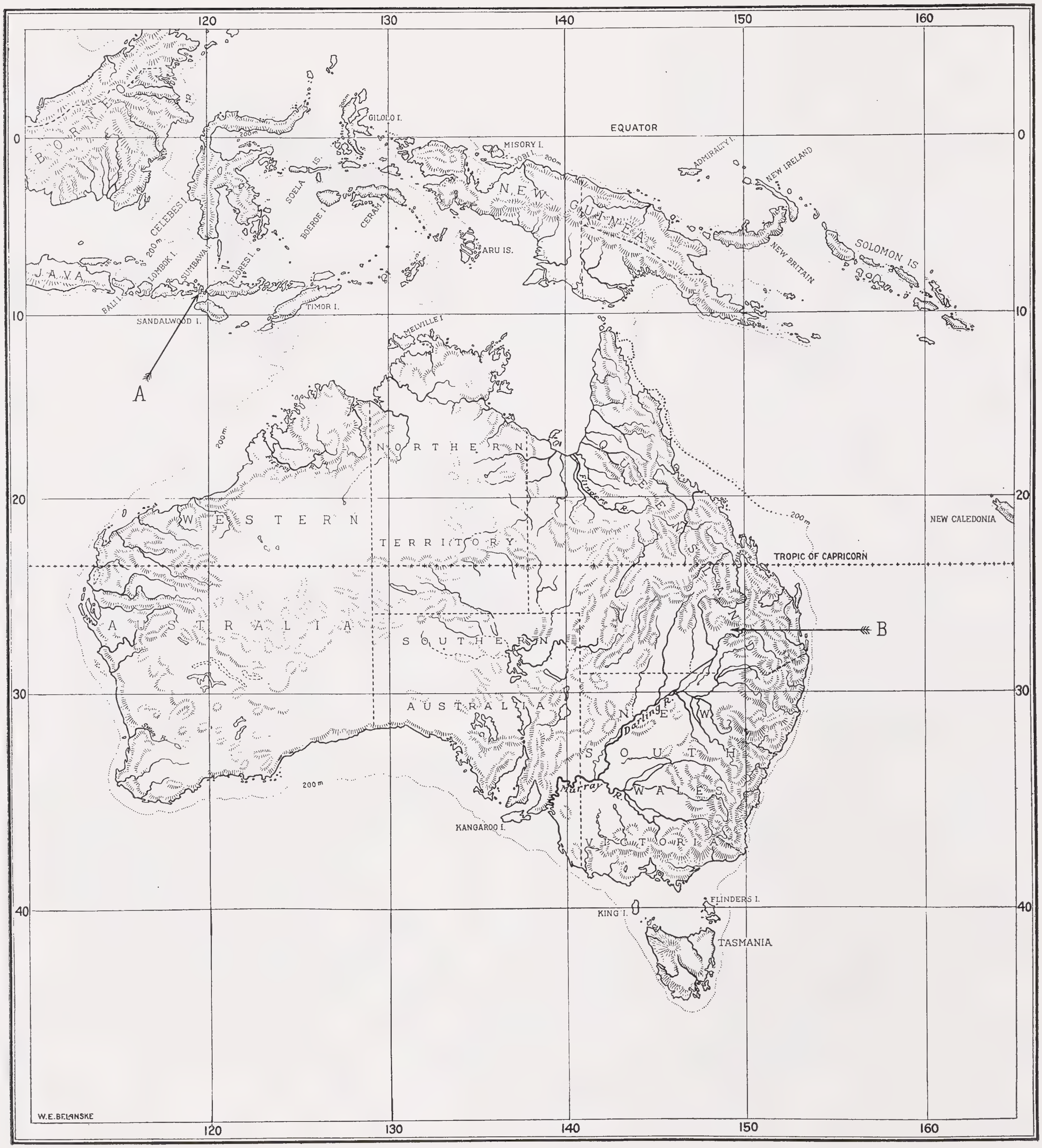


The same vertebrae seen from in front. (A) ordinary monitor; (B) Komodo "dragon"; (C) giant fossil monitor (*Varanus priscus*) of Australia, natural size. (C, after Owen; A, B, from originals.)

unmodified Asiatic element, a small and rather modified Australian element, and a minute and modified old Asiatic element.

In other words, the Lesser Sunda islands, including Komodo, amid all the ups and downs of this highly unstable region have managed to catch and hold a fair selection of the streams of animal life that were spreading from eastern Asia southeastward, and occasionally by reflex waves from Australia westward. With regard to the provenance of the Komodo lizards, we may appropriately close with a quotation from Professor Dunn (op. cit., 1927, p. 9).

"Whether *komodoensis* arrived in Komodo in



Map of the Australo-Malayan region, compiled by H. C. Raven. The arrow *A* points to Komodo Island; *B* points to the region in Queensland, Australia, where the type of the extinct *Varanus priscus* was found. The smaller living varanids (monitors, "goanas") range all over Australia, New Guinea and the Malayan region.

its present state of development and by what route it arrived at its present range are two unanswerable questions. The picture of evolution which presents itself to my own mind is one of ordinary lizards, in arid country, and free from competition from the higher mammals . . . , becoming large carnivores or perhaps carrion feeders. One of these, or one of the yet undifferentiated members of the same stock, possessing the same potentialities of development, arrived by unknown means in the Lesser Sundas and met the vanguard of the Placentals (Herbivores, as yet, and still unaccompanied by the higher and larger Carnivores, and as yet unfollowed by man). Here, these Australian emigrants persisted or developed, and here, in the same or in a latterly more restricted range, they can still be found."

KEY TO THE LIZARDS AND ALLIED FORMS

(*See Chart pages* 80 *and* 81)

The letters before the common names of each species correspond to the key-letters of the chart.

I. GECKOS; FAMILY GEKKONIDAE

(a.) Ringed Gecko, *Tarentula annularis*

II. SKINKS; FAMILY SCINCIDAE

(b.) Sand Skink, *Scincus scincus*
(c.) Stump-tailed Skink, *Trachysaurus rugosus*

III. TRUE LIZARDS; FAMILY LACERTIDAE

(d.) Green Lizard, *Lacerta viridis*

FAMILY TEIIDAE

(e.) Black Tegu, *Tupinambis nigropunctatus*

IV. DOUBLE ENDERS; FAMILY AMPHISBAENIDAE

(f.) Spotted Amphisbaena, *Amphisbaena fuliginosa*

V. SNAKES; SUBORDER OPHIDIA; FAMILY BOIDAE

(g.) Common Boa, *Constrictor constrictor*

VI. MONITORS; FAMILY VARANIDAE

(h.) Komodo "Dragon," *Varanus komodoensis*

VII. GILA MONSTERS; FAMILY HELODERMATIDAE

(i.) Mexican Beaded Lizard, *Heloderma horridum*

VIII. SLOW WORMS; FAMILY ANGUIDAE

(j.) Alligator Lizard, *Gerrhonotus multicarinatus*
(k.) European Glass Snake, *Ophisaurus apodus*

IX. ZONE TAILS; FAMILY ZONURIDAE

(l.) Spiny Lizard, *Zonurus giganteus*

X. IGUANIDS; FAMILY IGUANIDAE

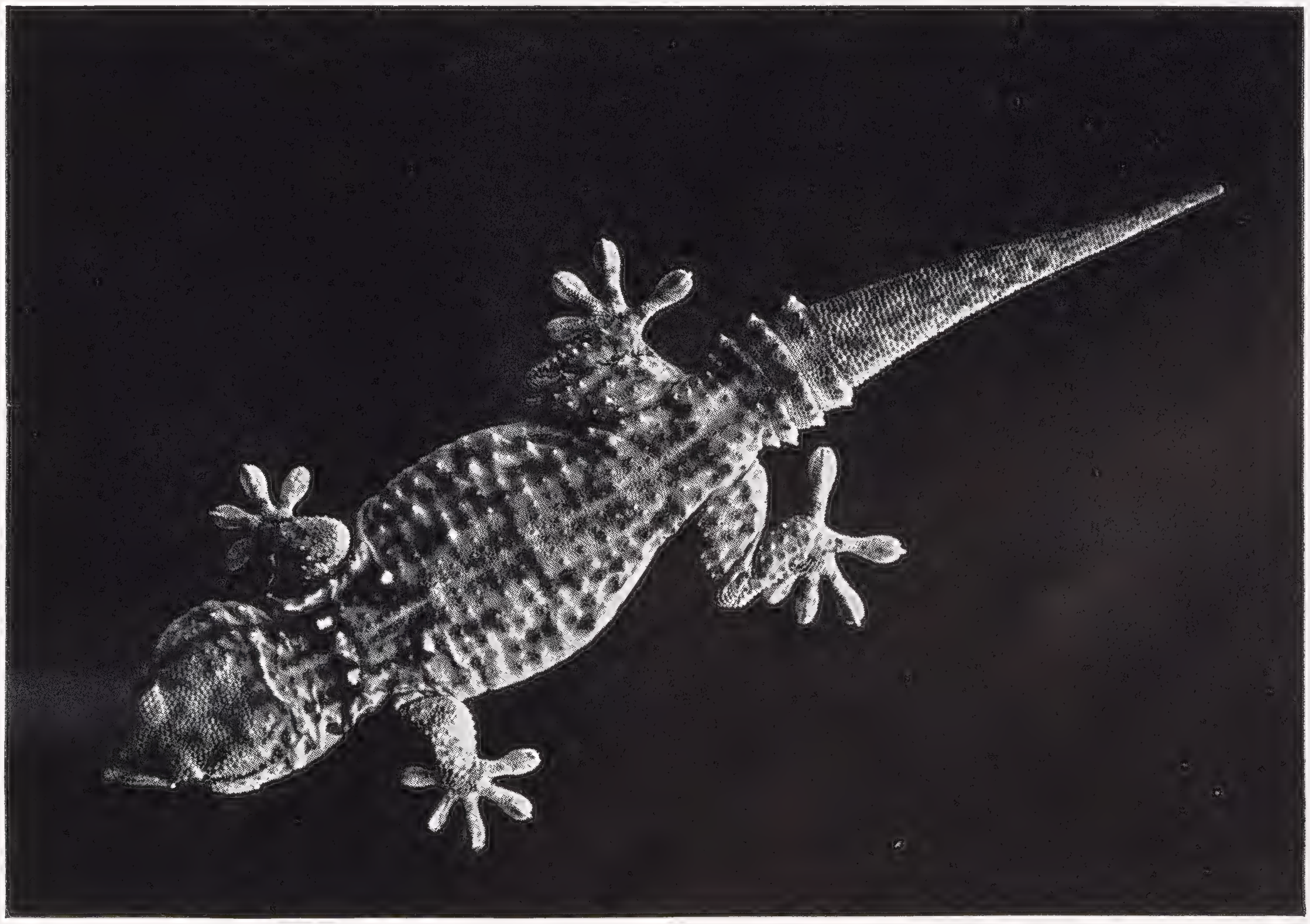
(m.) Rhinoceros Iguana, *Metopoceras cornutus*
(n.) Horned "Toad," *Phrynosoma cornutum*

XI. AGAMIDS; FAMILY AGAMIDAE

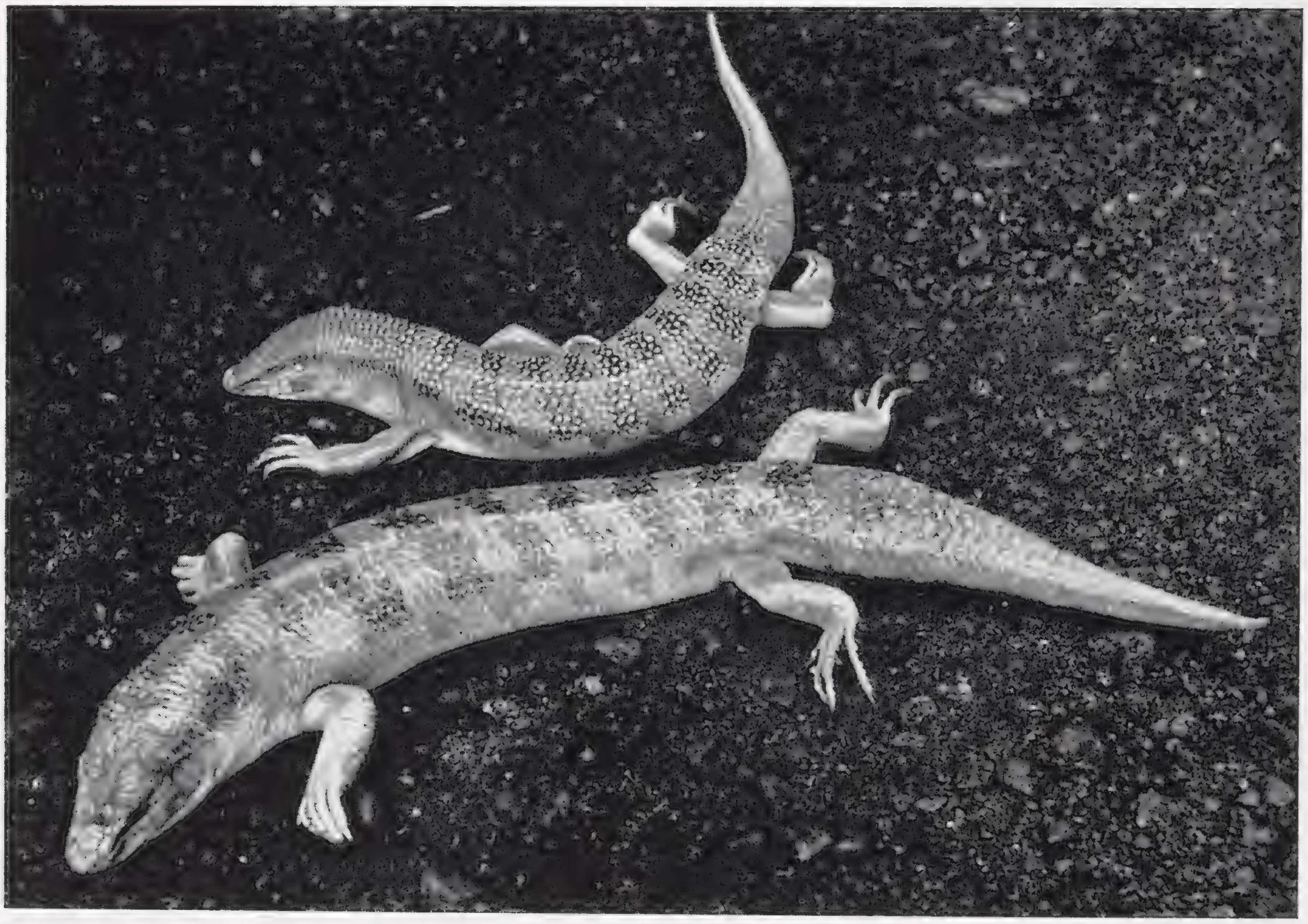
(o.) Moloch Lizard, *Moloch horridus*
(p.) Flying Dragon, *Draco volans*
(q.) Armed Agama, *Agama armata*
(r.) Bearded Dragon, *Amphibolurus barbatus*

XII. CHAMELEONS; FAMILY CHAMAELEONTIDAE

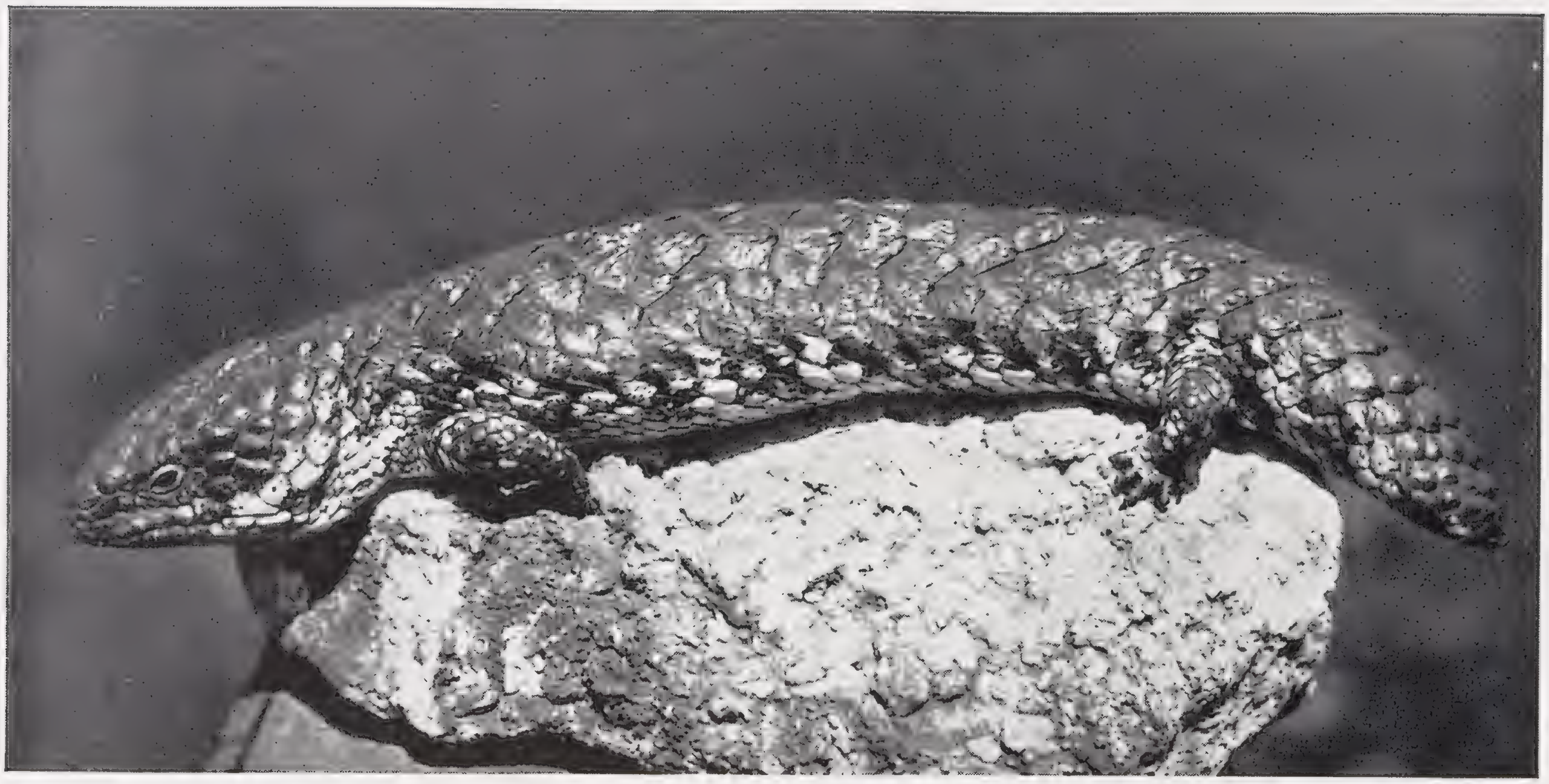
(s.) Common Chameleon, *Chamaeleon chamaeleon*



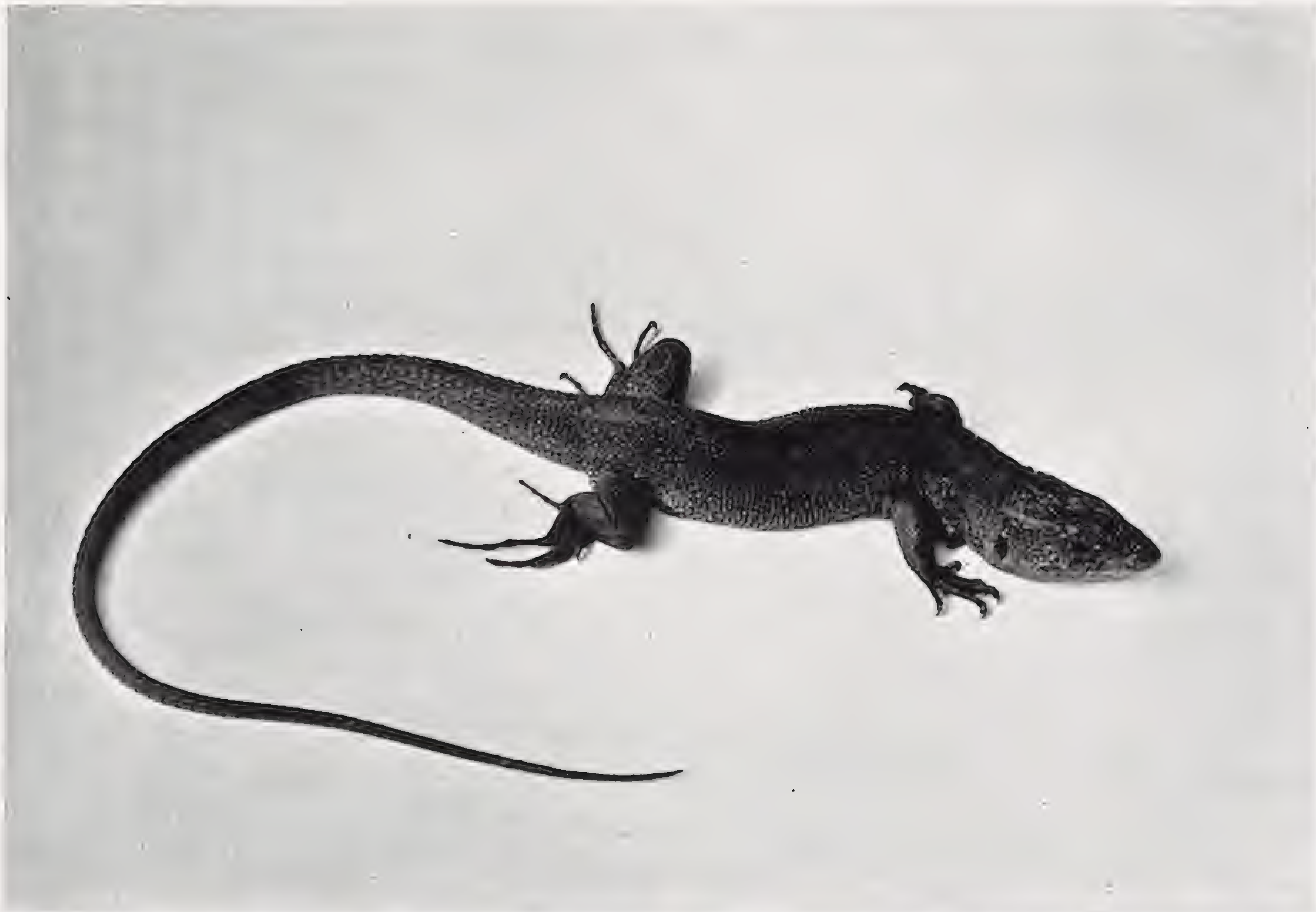
(a) Ringed Gecko, *Tarentula annularis*. Family *Gekkonidae*. The geckos form a large family and the greater number of species may be immediately distinguished from other lizards by their greatly dilated digits, the toes being expanded in the form of adhesive pads, the feet appearing from above somewhat like those of tree toads. These enable the gecko to cling easily to a vertical sheet of glass, and to run with celerity across a ceiling. Their scalation differs from that of the lizards in being extremely fine, or granular, and it is often studded with tubercles, giving it the appearance of a toad's skin. Photograph by Elwin R. Sanborn.

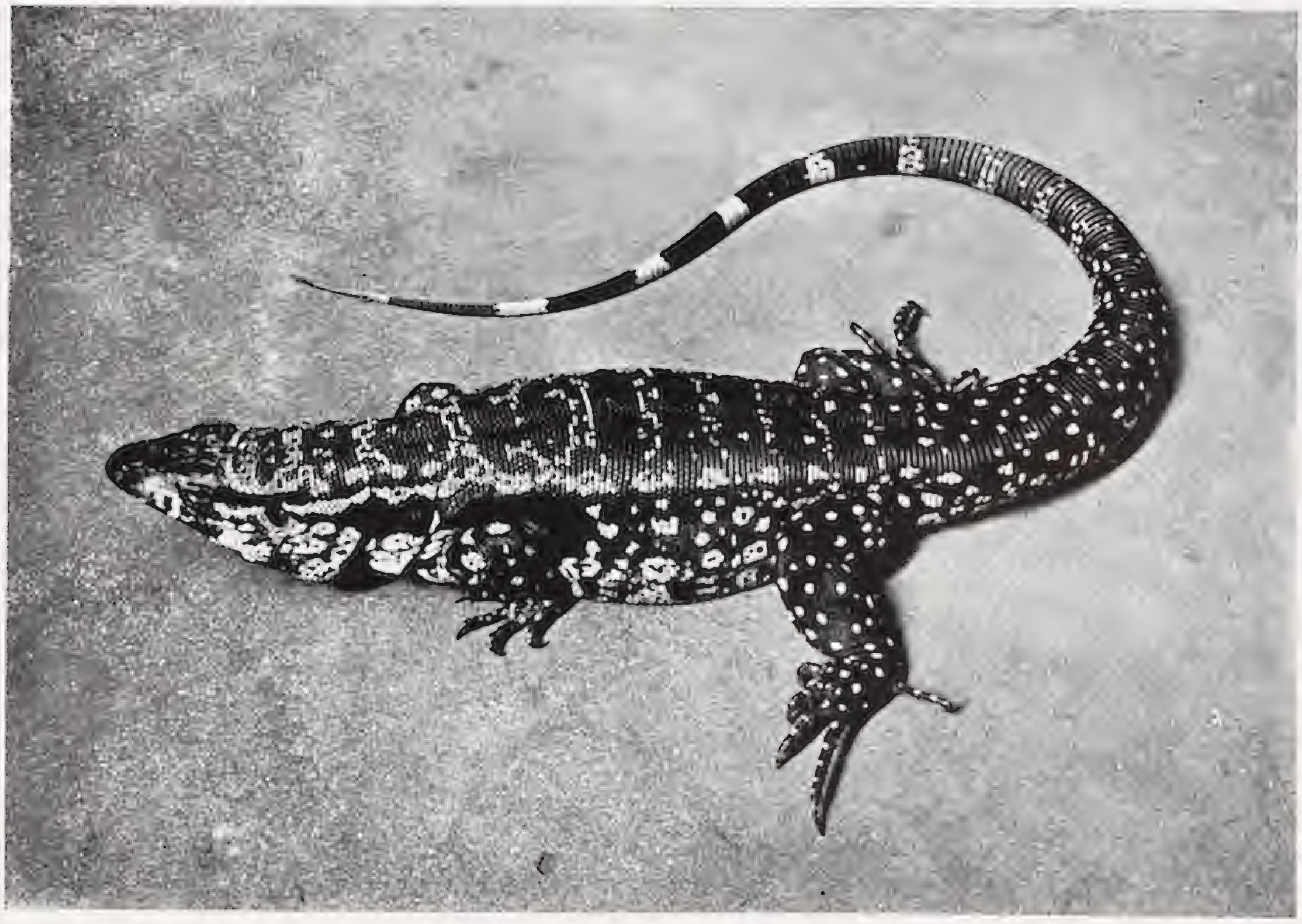


(b) Sand Skink; Sand "Fish", *Scincus scincus.* Family Scincidae. Close examination of this creature shows marked modification for a life in the powdery, desert sands. The snout is sharp and used as a burrow-wedge, while a fringe of scales on the toes enables it to walk on the loose surface of the sand without sinking. Photograph by Raymond L. Ditmars.



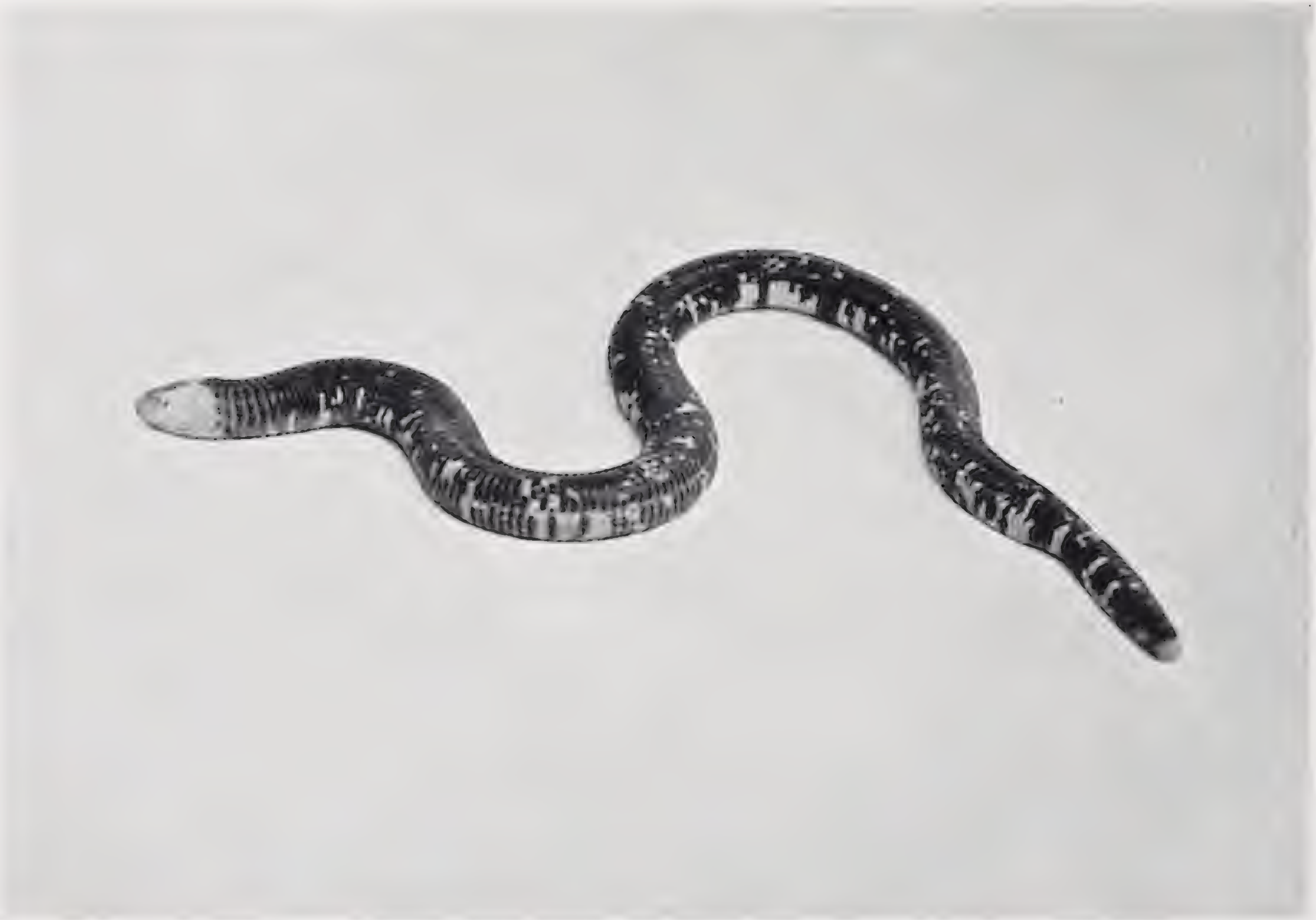
(c) Stump-tailed Lizard, *Trachysaurus rugosus,* of the Family Scincidae, is one of the strangest of all the Australian lizards. At a few yards distance, its tail lacks only mouth and eye-marks to be a head in appearance. It is a snake killer, a formidable enemy of the many venomous reptiles with which Australia abounds, and the reptile when seized is helpless in its bulldog-like grip. This genus is represented by but one species. Photograph by Charles Barrett.

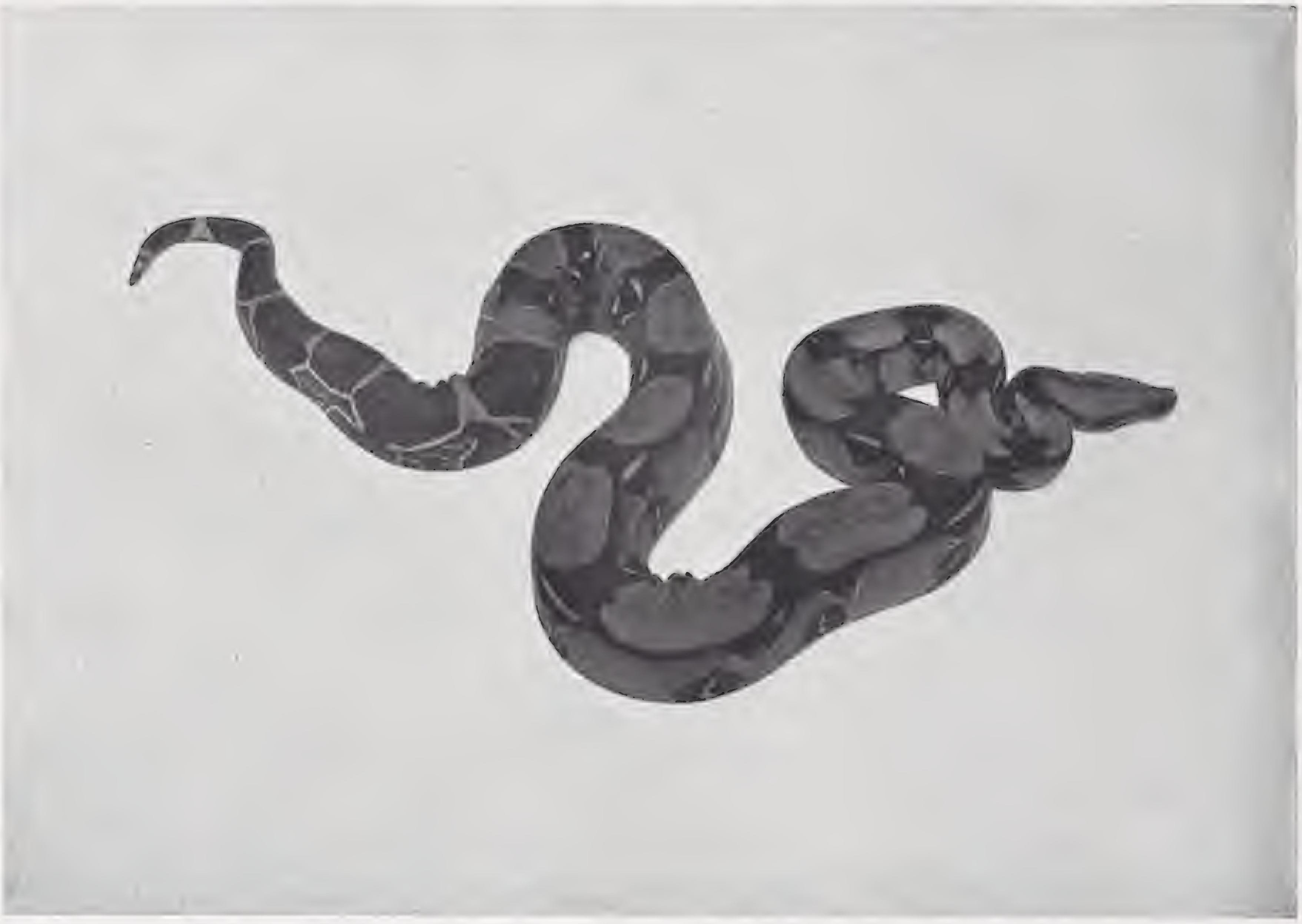




(d) Green Lizard, *Lacerta viridis*. Family Lacertidae. Central and southern Europe and southern Asia. Here is a typical lizard in all that the name implies. It is of moderate size, without eccentric development of scalation or body contour. Allied species of this type are abundant in central and southern Europe. An allied species, *Lacerta agilis*, is alleged to be the only reptile in Ireland, although it is said that grass snakes have been observed. Photograph by Raymond L. Ditmars.

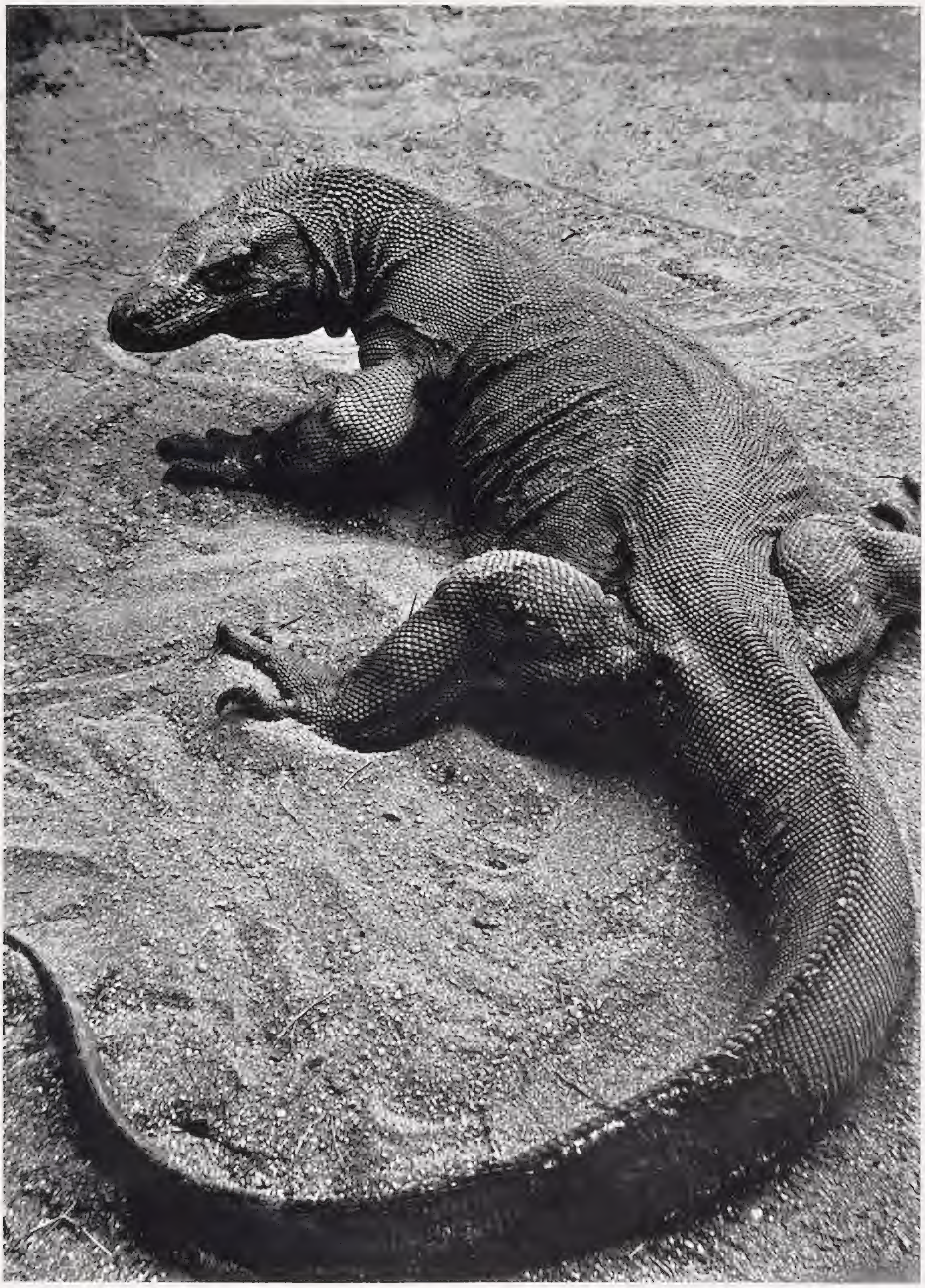
(e) Black Tegu, *Tupinambis nigropunctatus*. Family Teiidae. Guianas and Brazil. A swift running and powerful lizard, with brilliant pattern of yellow on glossy black scales. The tegus are exceptionally hardy as captives. The specimen shown in the photograph lived in the Zoological Park for over ten years. Photograph by Raymond L. Ditmars.



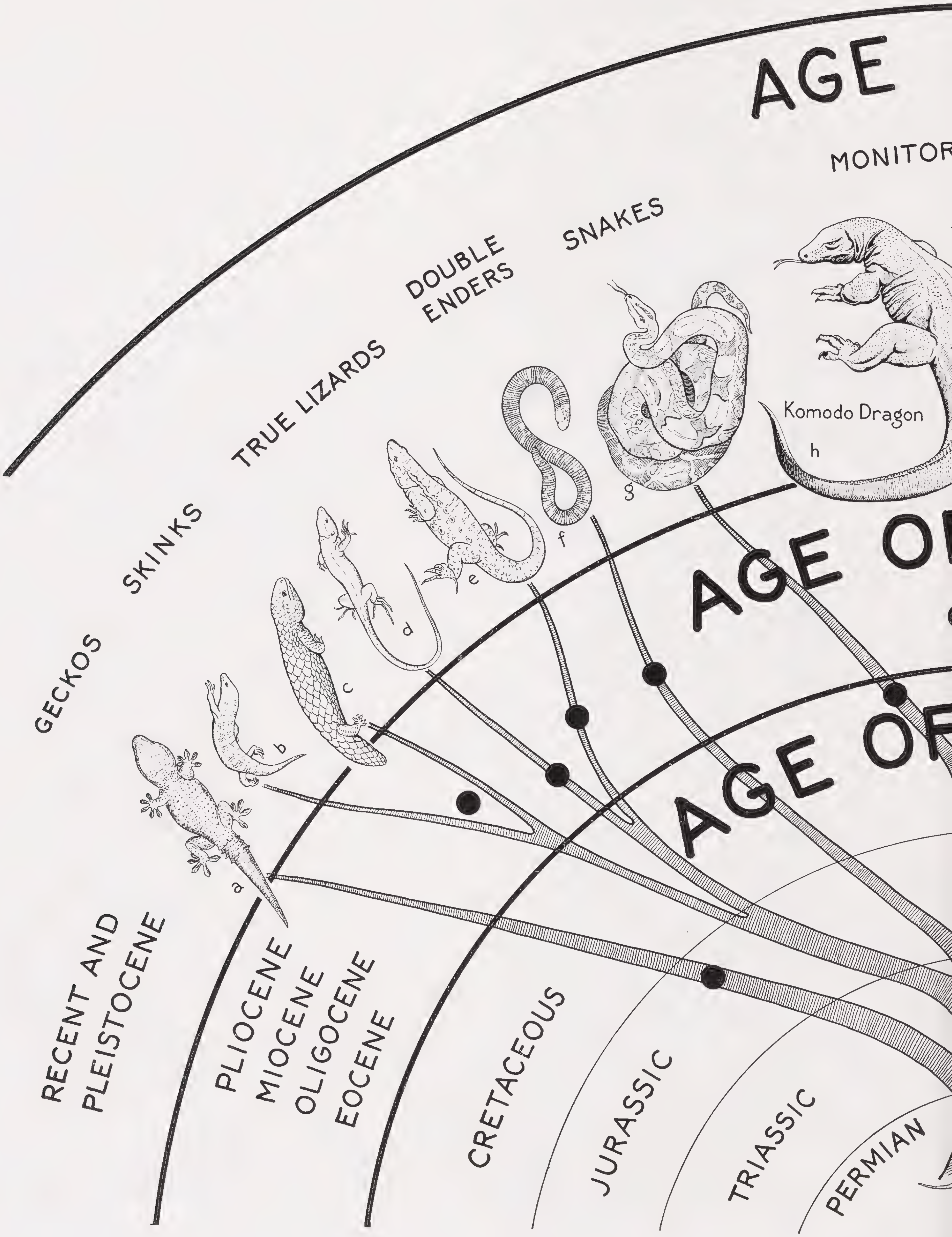


(f) Spotted Amphisbaena, *Amphisbaena fuliginosa.* Family Amphisbaenidae. All members of the family to which this species belongs have a worm-like body with many circular rings or segments, which are movable and hence carry the creature along the ground in a fashion similar to that of an earthworm. All of them spend much time burrowing. The eyes are minute, hidden under the skin, and therefore almost useless. Photograph by E. R. Osterndorff.

(g) Common Boa, *Constrictor constrictor.* Suborder Ophidia. Family Boidae. The family containing the boas and pythons, with several related families, of smaller, more degenerate members, appear to show close relationship to lizards owing to their having vestiges of posterior limbs. These are internal, near the base of the tail, but each protrudes as a claw or spur. Photograph by Elwin R. Sanborn.



(h) Giant Monitor, *Varanus komodoensis.* Family Varanidae. Island of Komodo and westerly portion of Flores, in the Dutch East Indies. Recently discovered, this powerful lizard astonished students of reptiles. It grows to a length of considerably over ten feet, and attains a weight of close to one hundred and fifty pounds. It is the largest existing species of lizard, although not greatly eclipsing the big Ceylonese Monitor, which, however, is of much lighter build. This and another living specimen were the first to be exhibited in the United States. They were collected by the Douglas Burden Expedition to the Island of Komodo in 1926. Photograph by Elwin R. Sanborn.



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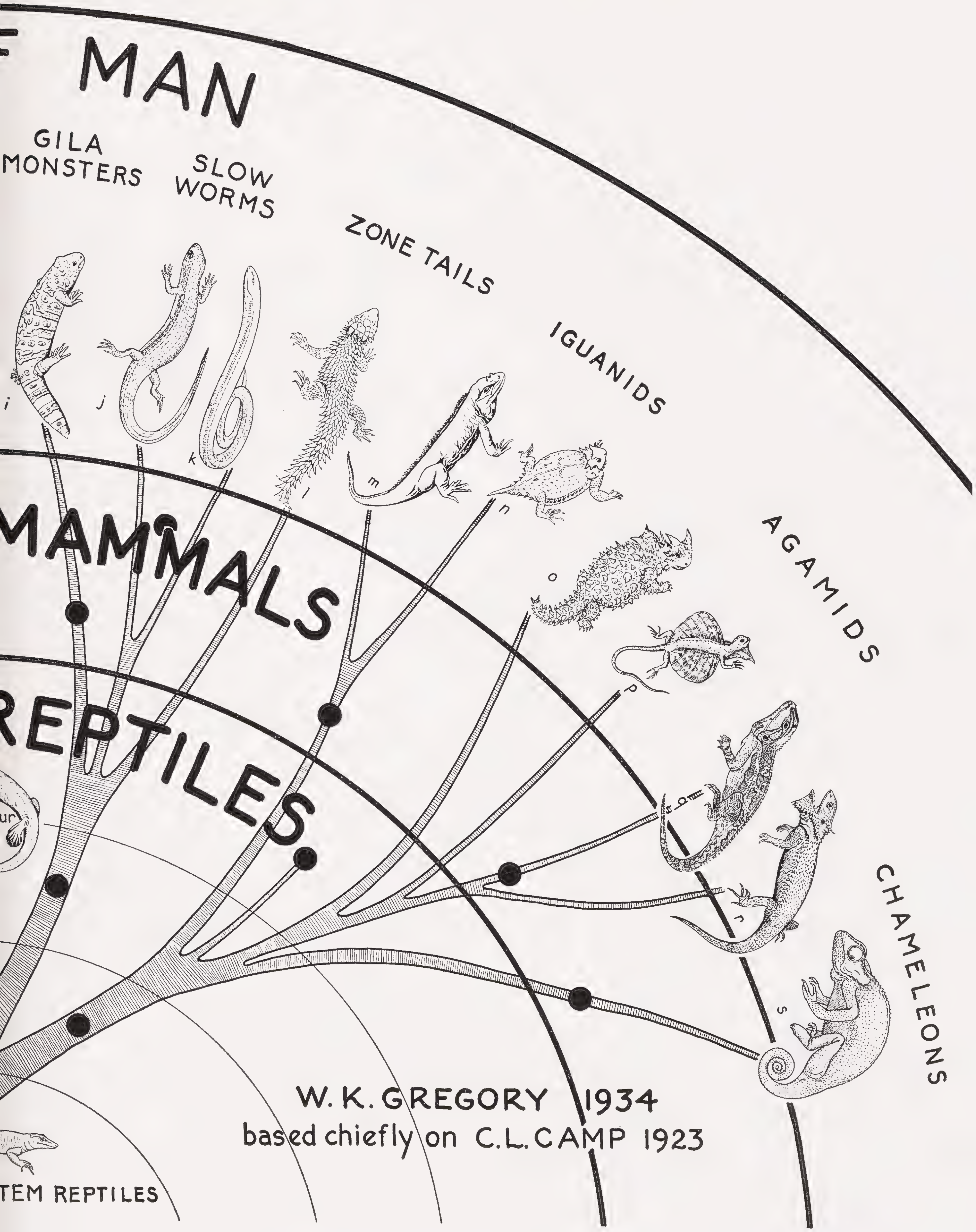

OF THE LIZARDS

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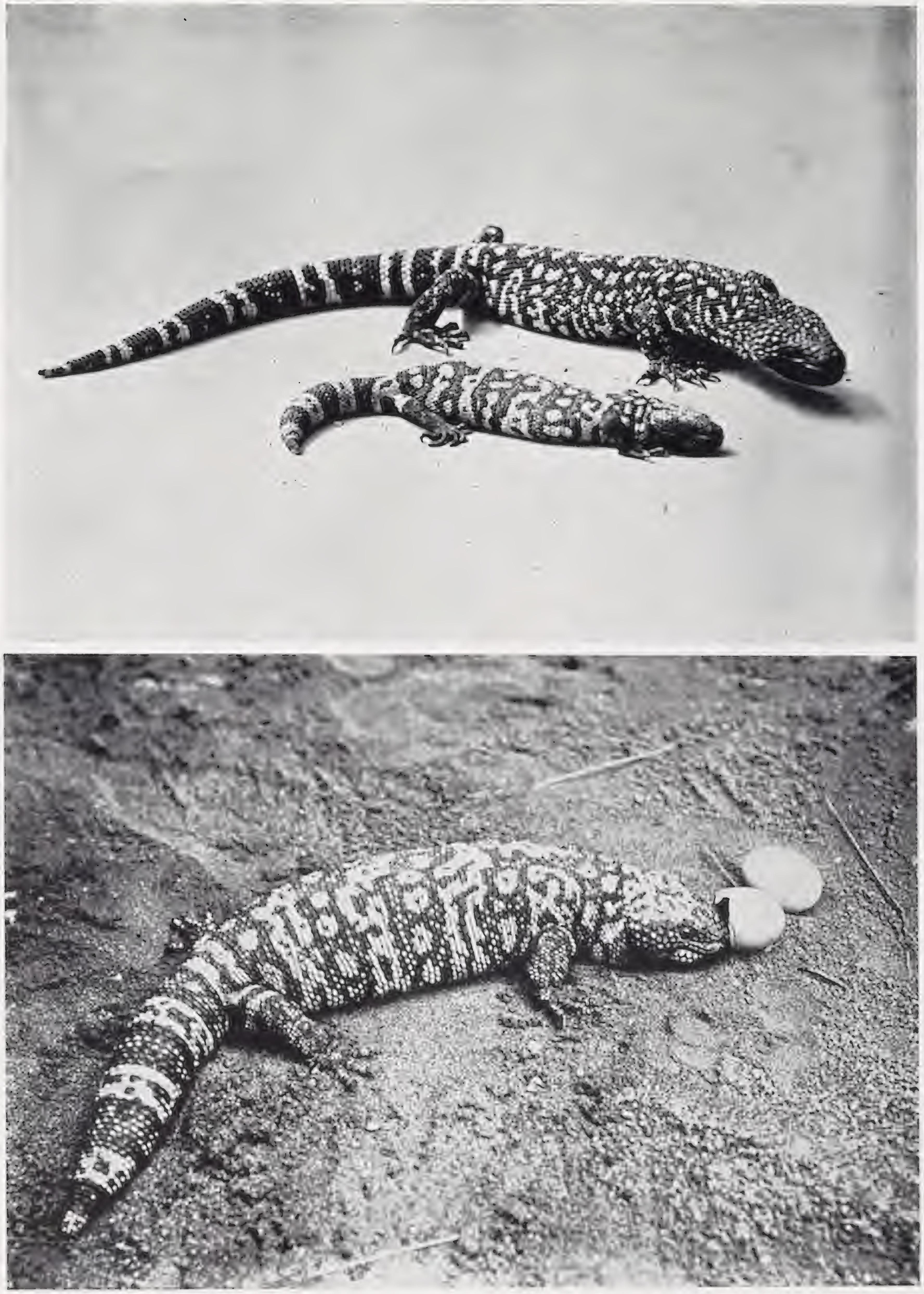
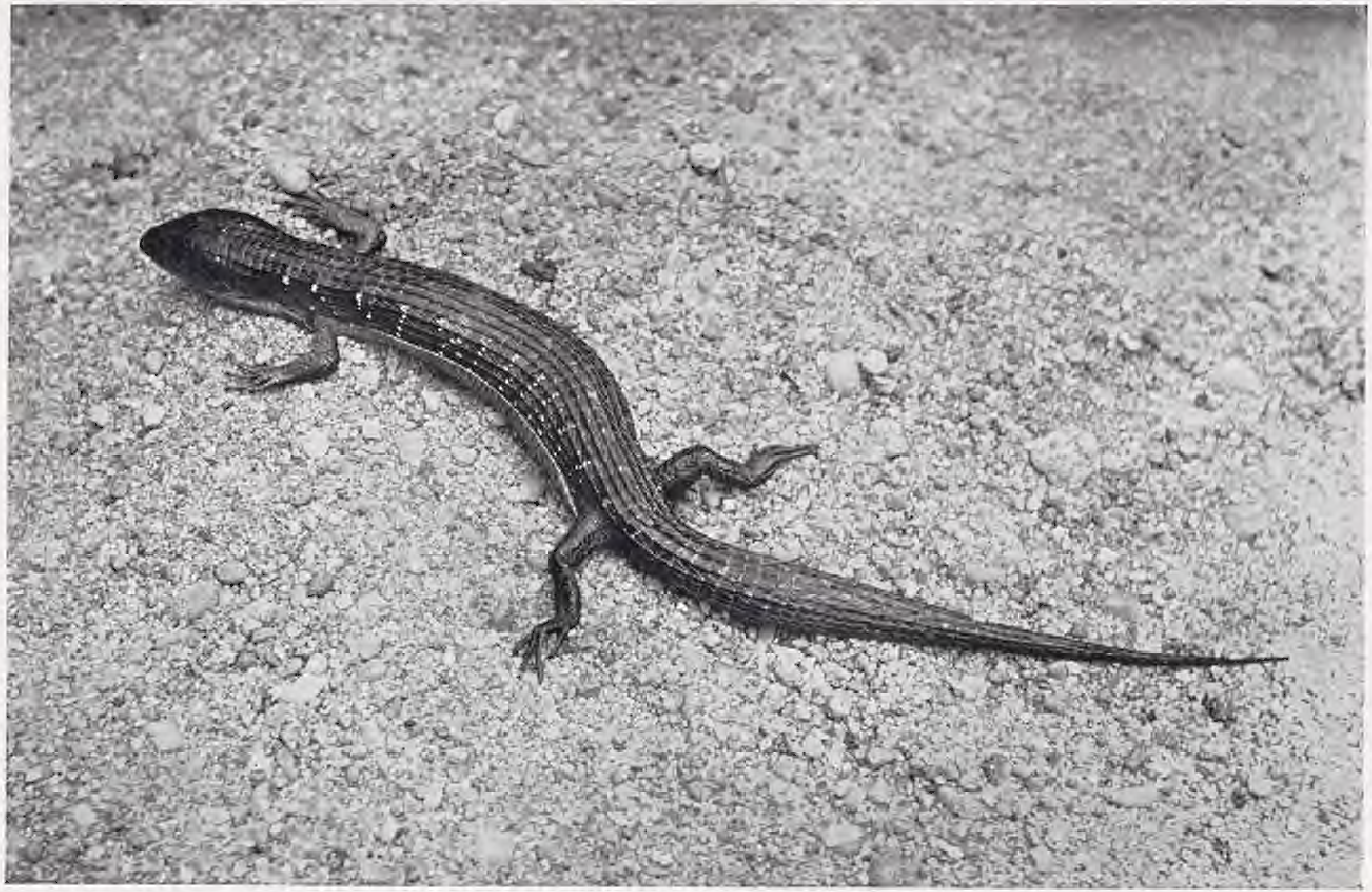
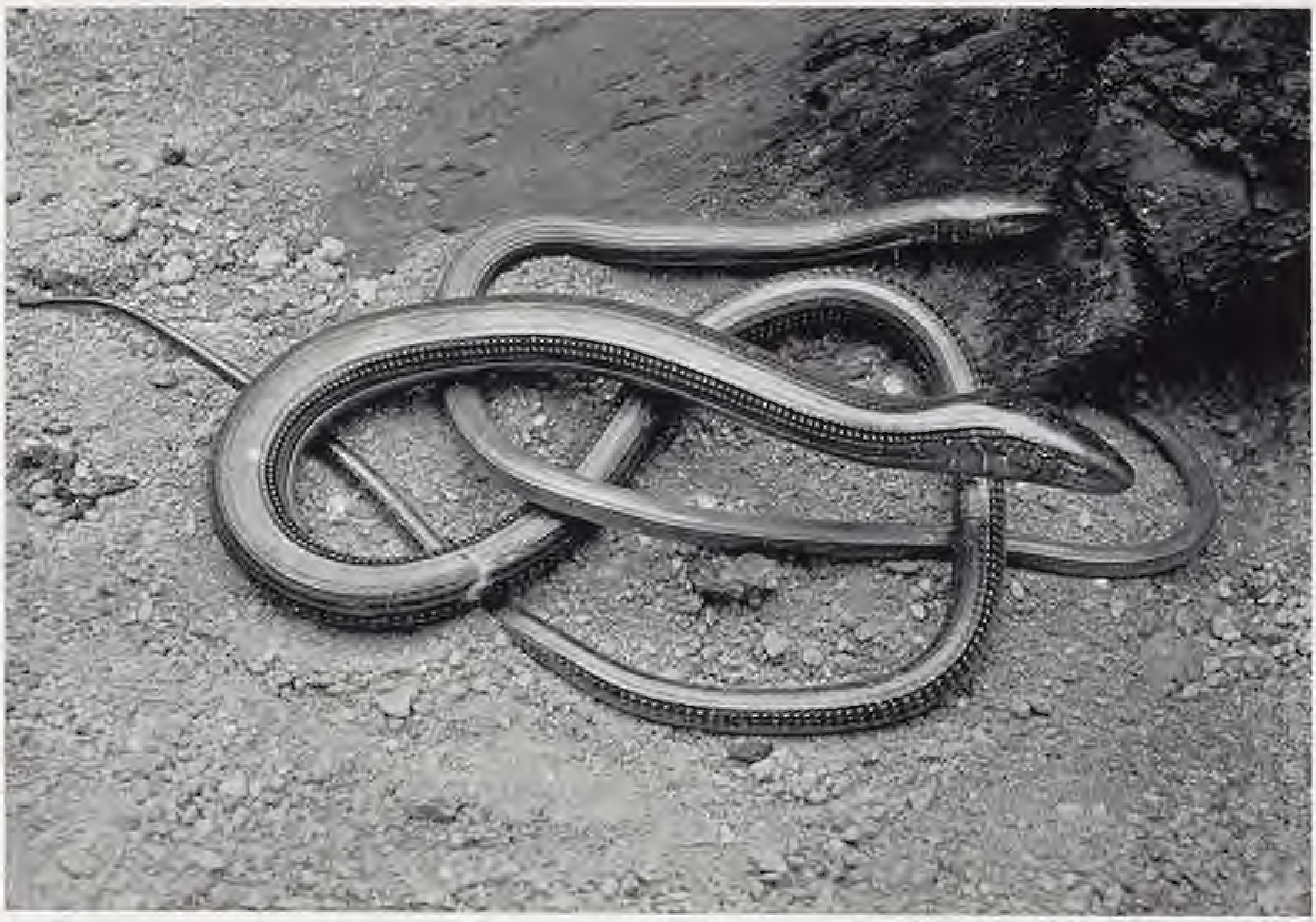
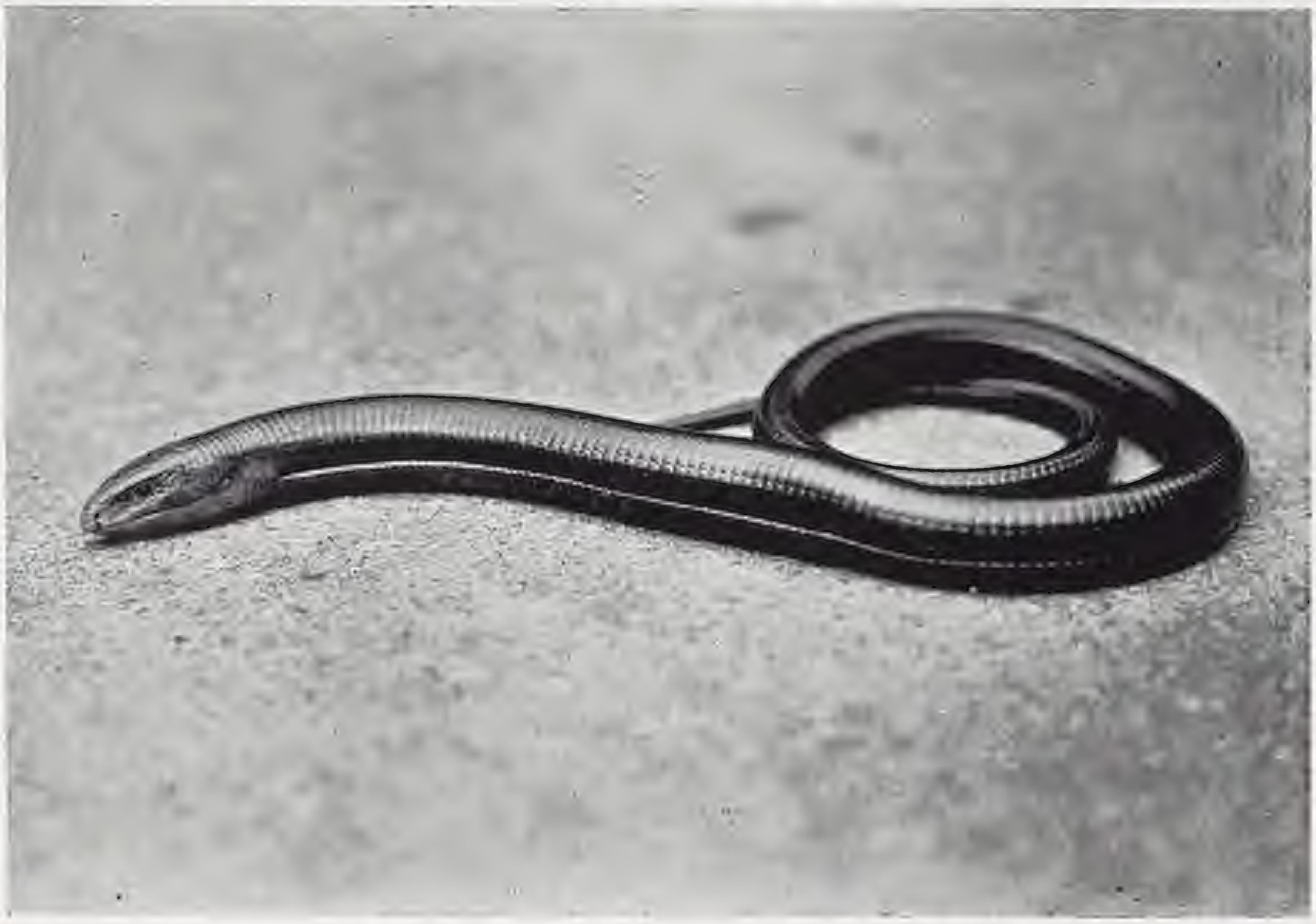


(i) Beaded Lizards, *Heloderma*. FAMILY HELODERMATIDAE. Among the twenty-five hundred kinds of lizards, these are the only known poisonous species. They form a family containing a single genus with its two characteristic species. The larger figure above is that of the Mexican Beaded Lizard, *Heloderma horridum*. LOWER—Gila Monster, *Heloderma suspectum*. Habitat is defined as extreme southern Utah, and Nevada, Arizona and Sonora. Enlarged glands and grooved teeth in the lower jaw constitute the poison apparatus. The venom is similar to that of snakes, but much less virulent in its effects. Photographs by Elwin R. Sanborn.



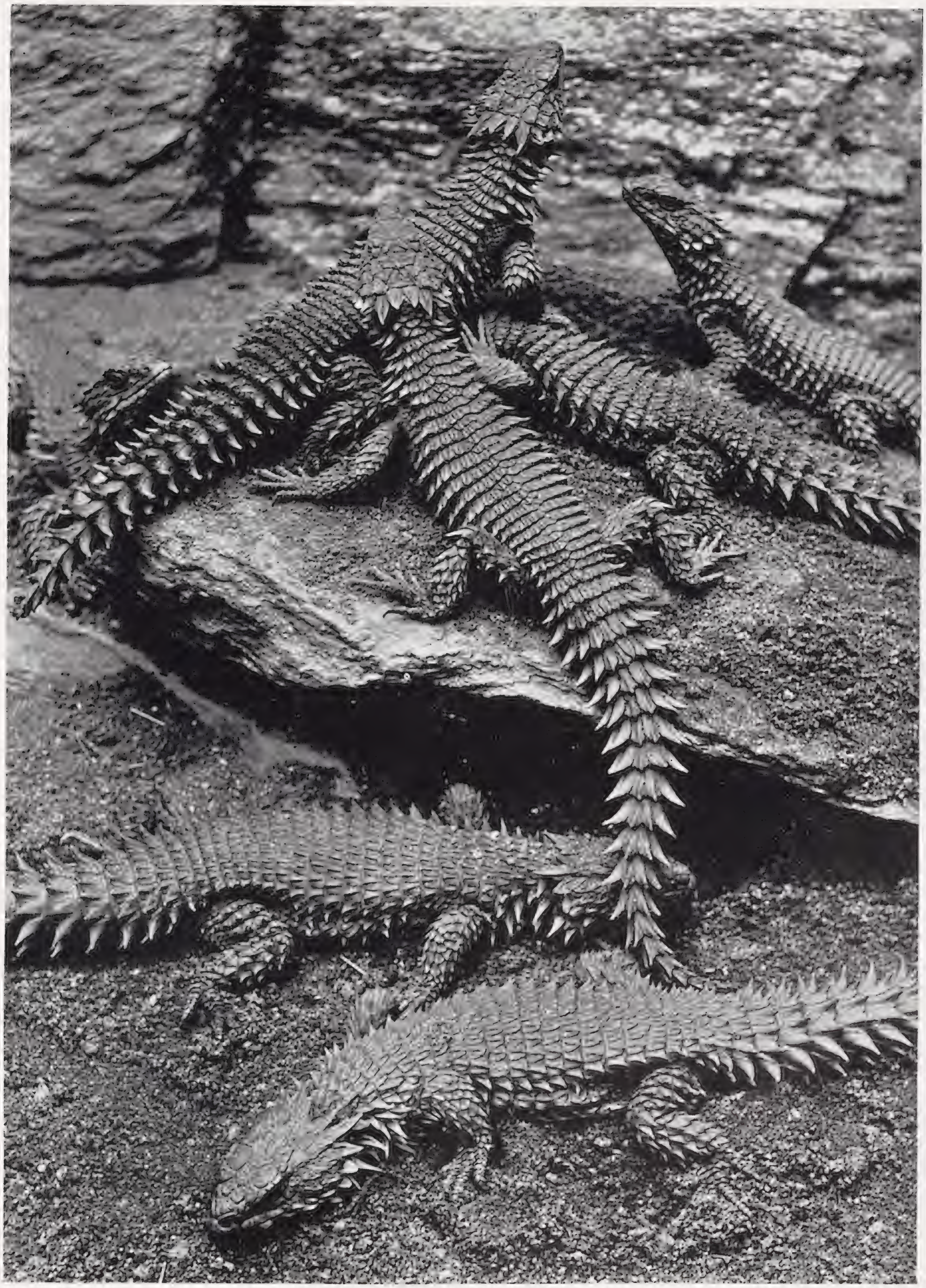
(j) Alligator Lizard, *Gerrhonotus multicarinatus*. California. About six inches long and covered with square, leathery-looking scales, this lizard represents a curious family—the Anguidae. The members have bony plates beneath the scales; some have well-developed limbs and others are limbless, crawling like serpents and often being mistaken for snakes. Seven species of alligator lizards inhabit the western portion of the United States and northern Mexico. One hardy species ranges northward through western Washington and Oregon to Vancouver Island. Photograph by Raymond L. Ditmars.



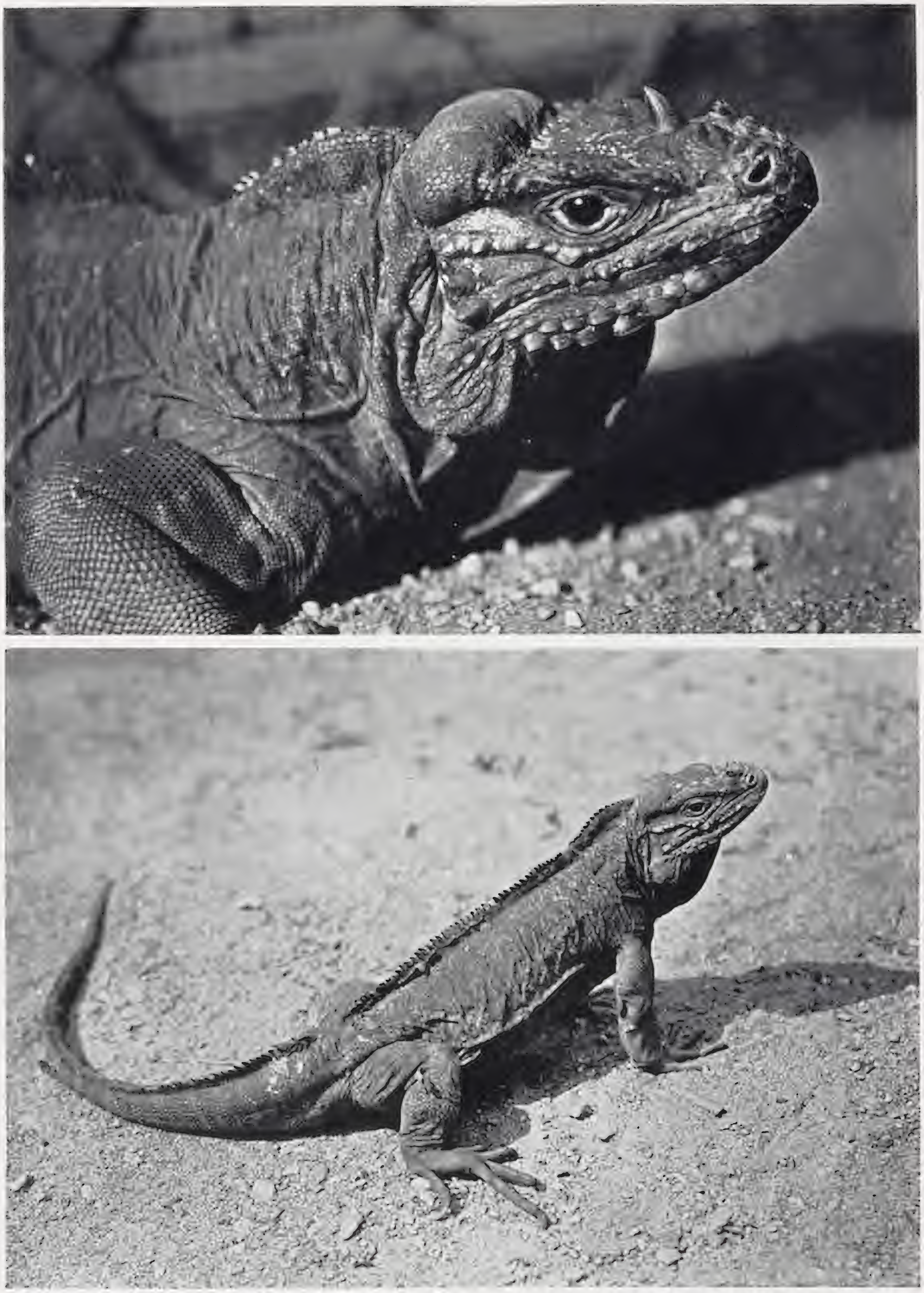


(k) European glass "snake", *Ophisaurus apodus*. Family Anguidae. This true lizard, a member of the family Anguidae, is larger than the American species, attaining a length of three feet. The actual body forms about one-third its length. A pair of minute flaps at the vent are the vestiges of limbs.

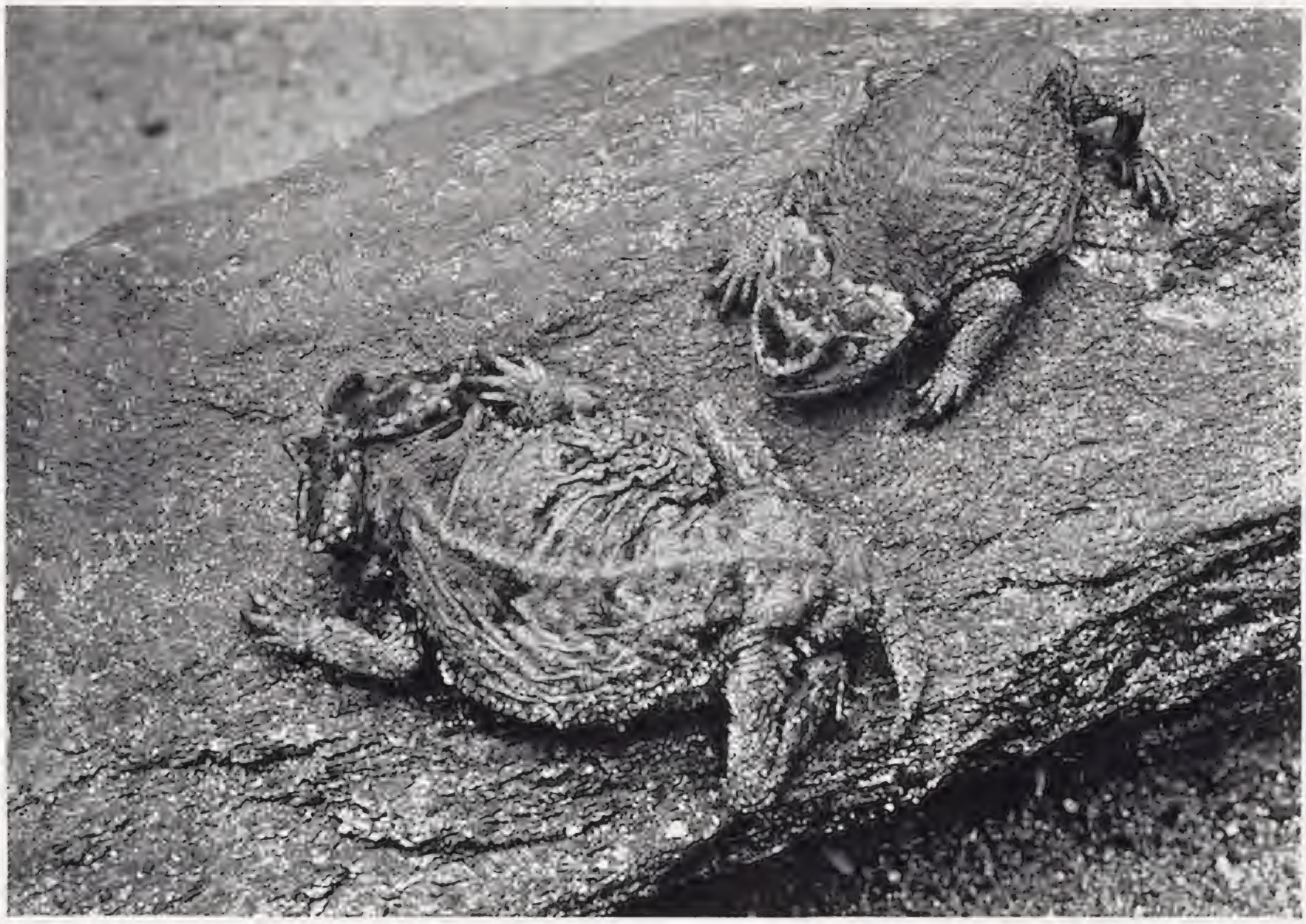
Ophisaurus ventralis, of the southern United States, is commonly alleged to break into pieces which "crawl" together and form a reunited reptile. The tail is actually brittle and may be broken off in defense, the writhing of the broken section attracting the enemy's attention. It eventually may be replaced by the growth of a new member. Photographs by Raymond L. Ditmars.

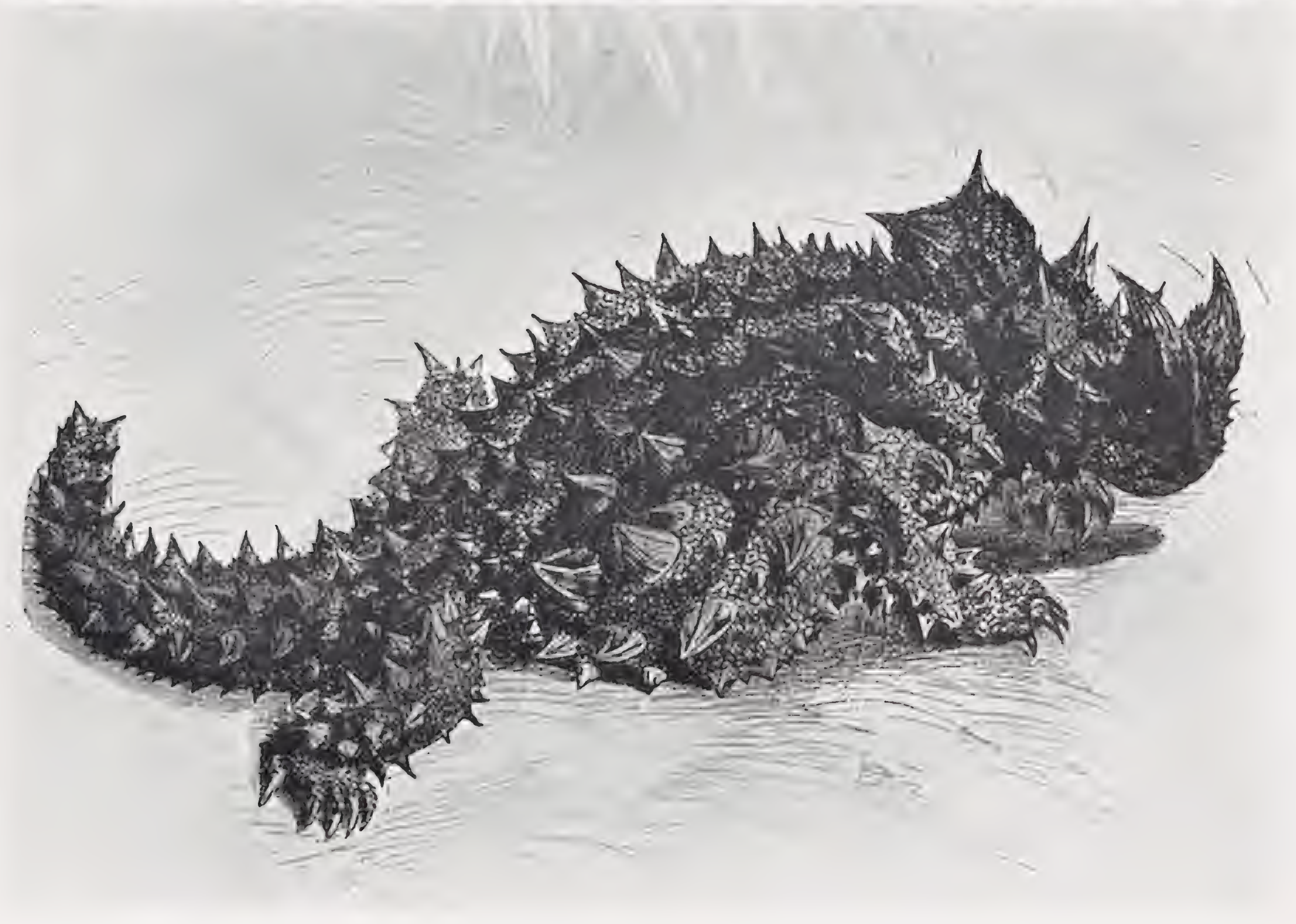


(1) Spiny Lizard; Spine-tailed Lizard, *Zonurus giganteus.* FAMILY ZONURIDAE. Bristling with horny spines, this lizard would ordinarily appear to be quite well protected, but it is alleged to make use of this means of defense specifically by crawling into its burrow head first, leaving the formidable tail to block the passage. A large specimen will measure about eighteen inches. It may be classed also as a desert type, as it lives in dry, sterile areas. It is interesting to note that the greater number of desert lizards have acquired enlarged, spiny scales, which is the tendency of many desert plants. Photograph by Elwin R. Sanborn.



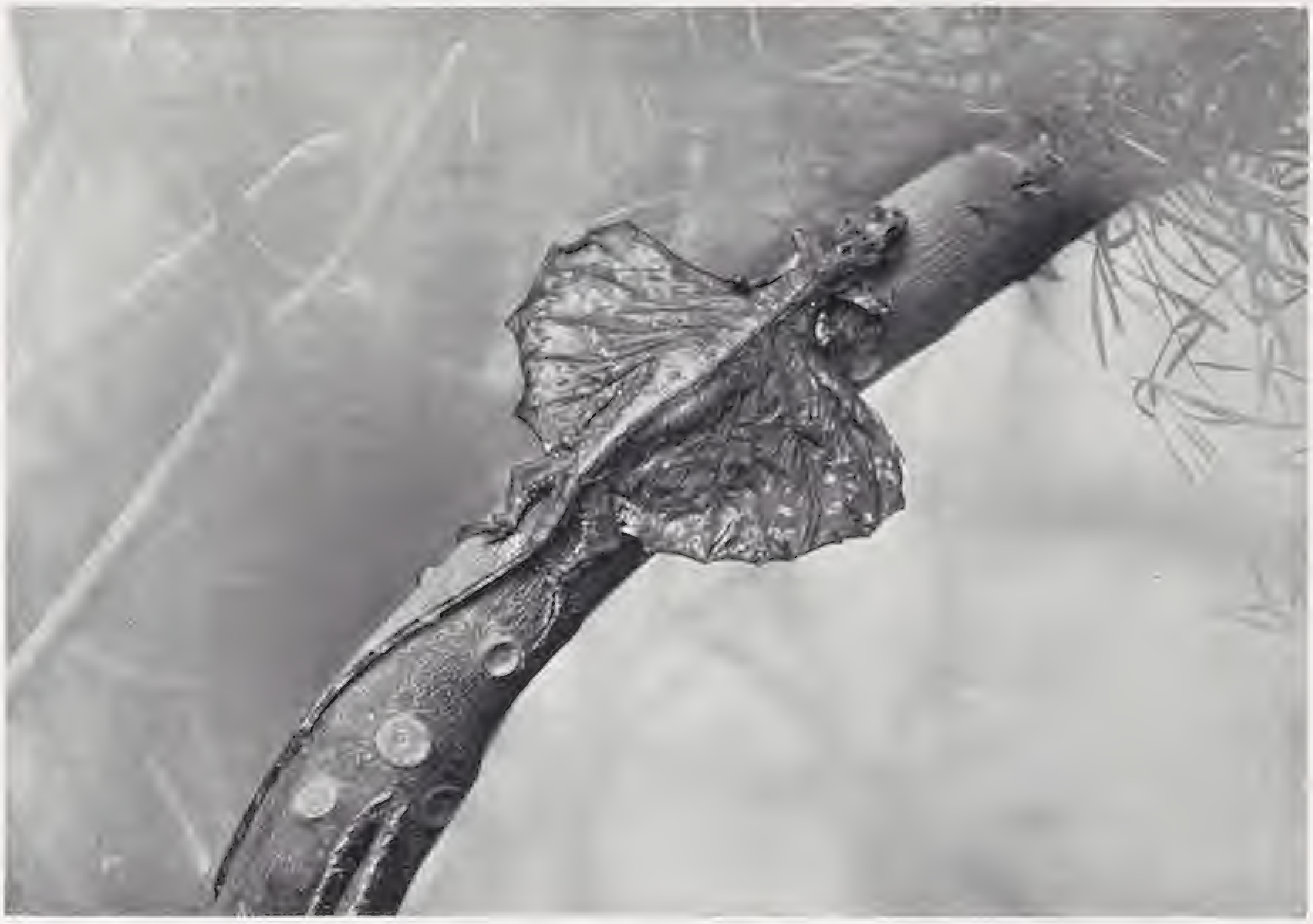
(m) Rhinoceros Iguana, *Metopoceras cornutus*. Family Iguanidae. Haiti. There is a close rivalry between this species and the big land iguana of the Galapagos Islands as to size and bulk. It is a powerful, terrestrial animal and digs caves in the sand and coral slopes of the island. It is sometimes hunted with dogs and is a savage adversary. Dull brown in color, with wattles and protuberances upon the head, and sinister countenance surmounted by the rhinoceros-like horn, it recalls the restorations of prehistoric dinosaurs. It feeds commonly upon leaves and flowers, but will attack and devour small mammals and young birds. Photographs by Elwin R. Sanborn.

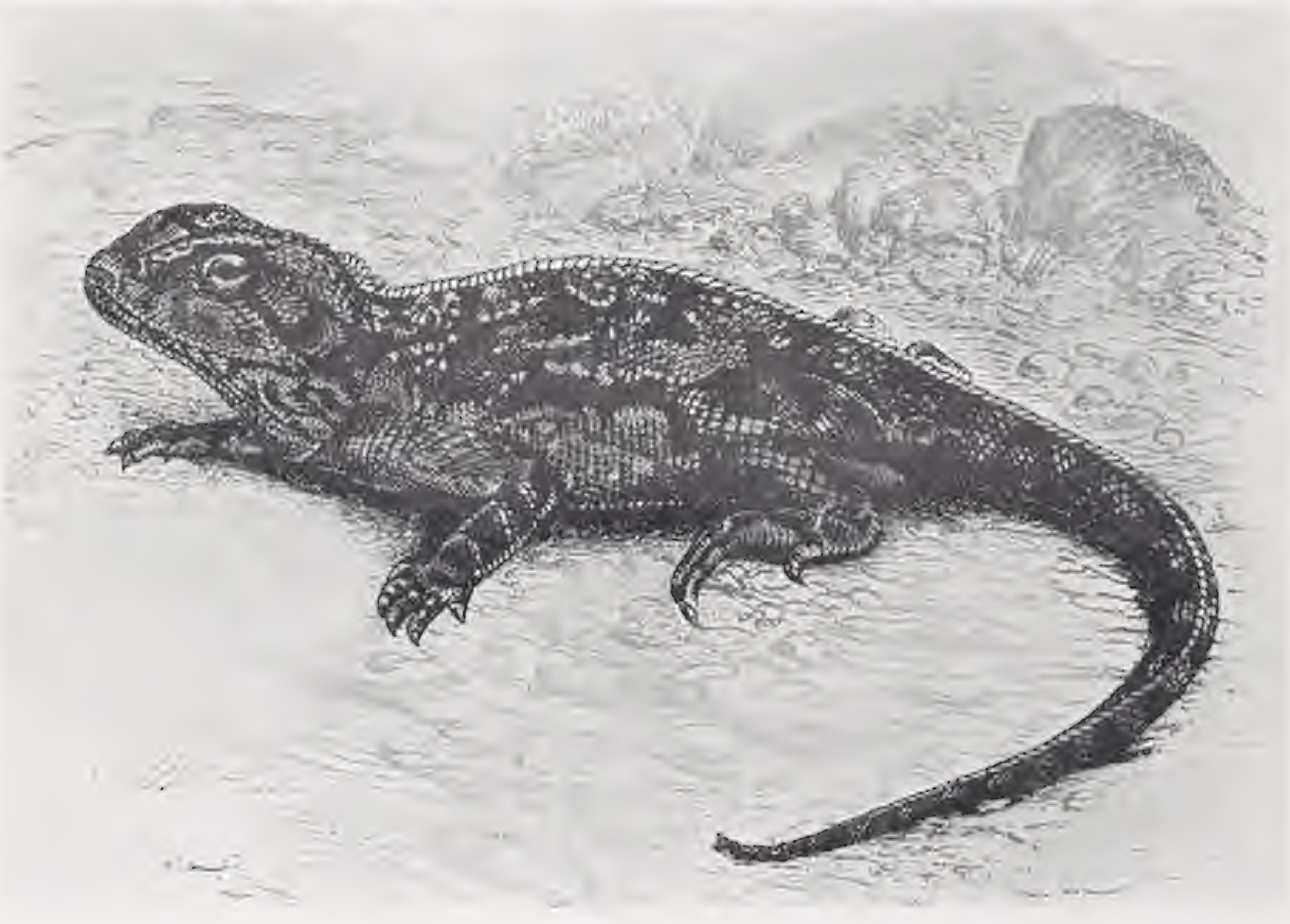




(n) Ditmars' Horned "Toad", *Phrynosoma ditmarsi.* FAMILY IGUANIDAE. Region of the Mexican Boundary at Arizona and New Mexico. With this species the horns are reduced to a rudimentary stage, although the sides of the head are developed into projecting ridges. The body is rather smooth and particularly toad-like. Photograph by Raymond L. Ditmars.

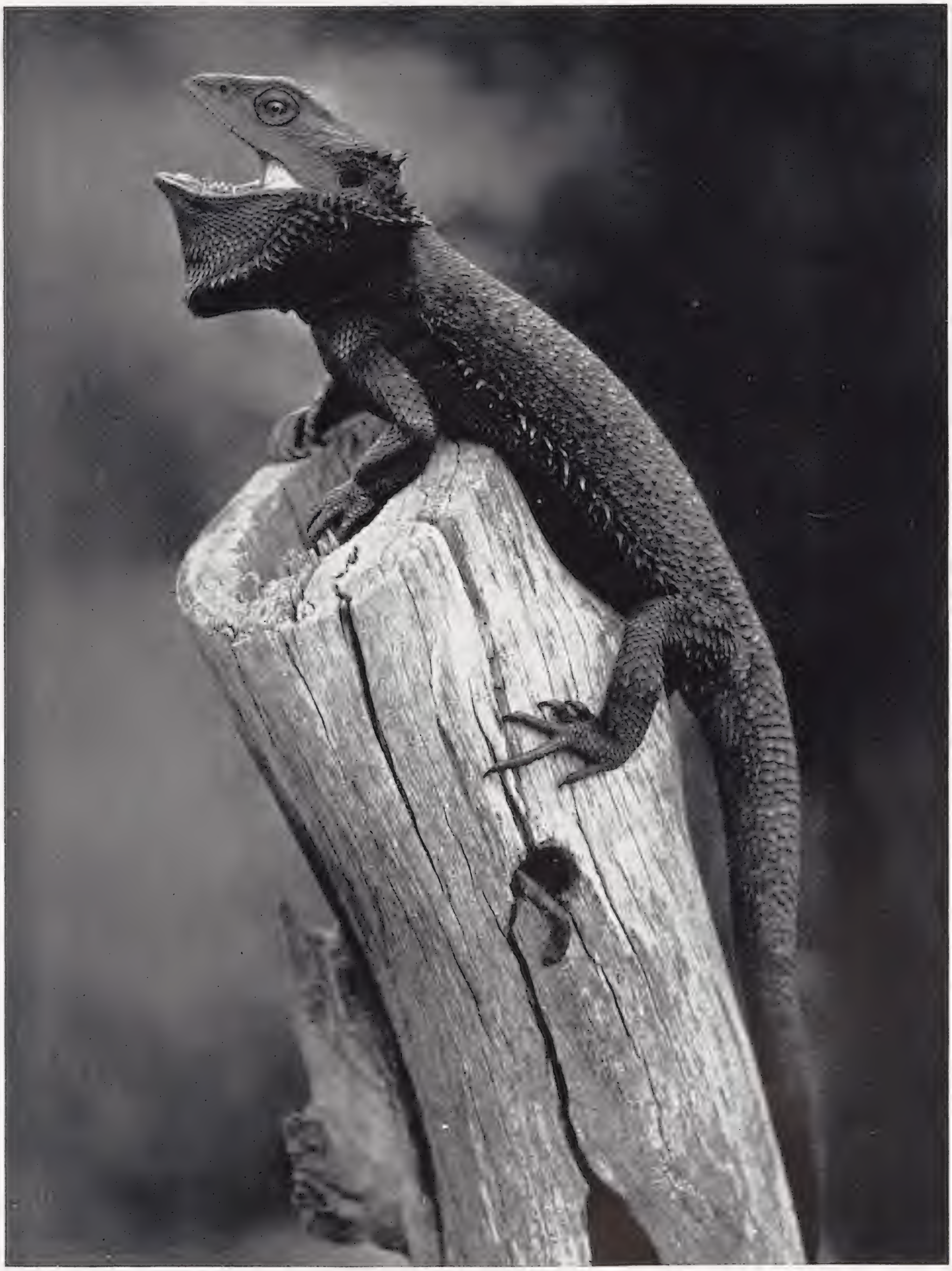
(o) Moloch, *Moloch horridus.* FAMILY AGAMIDAE. This member of an Old World group, the AGAMIDAE, indicates a curious parallelism in development of that family, as compared with the New World IGUANIDAE. Thus the Moloch is a form similar to the Horned "Toad". A number of the members are strikingly like the New World iguanas. Lydekker. Royal Natural History.



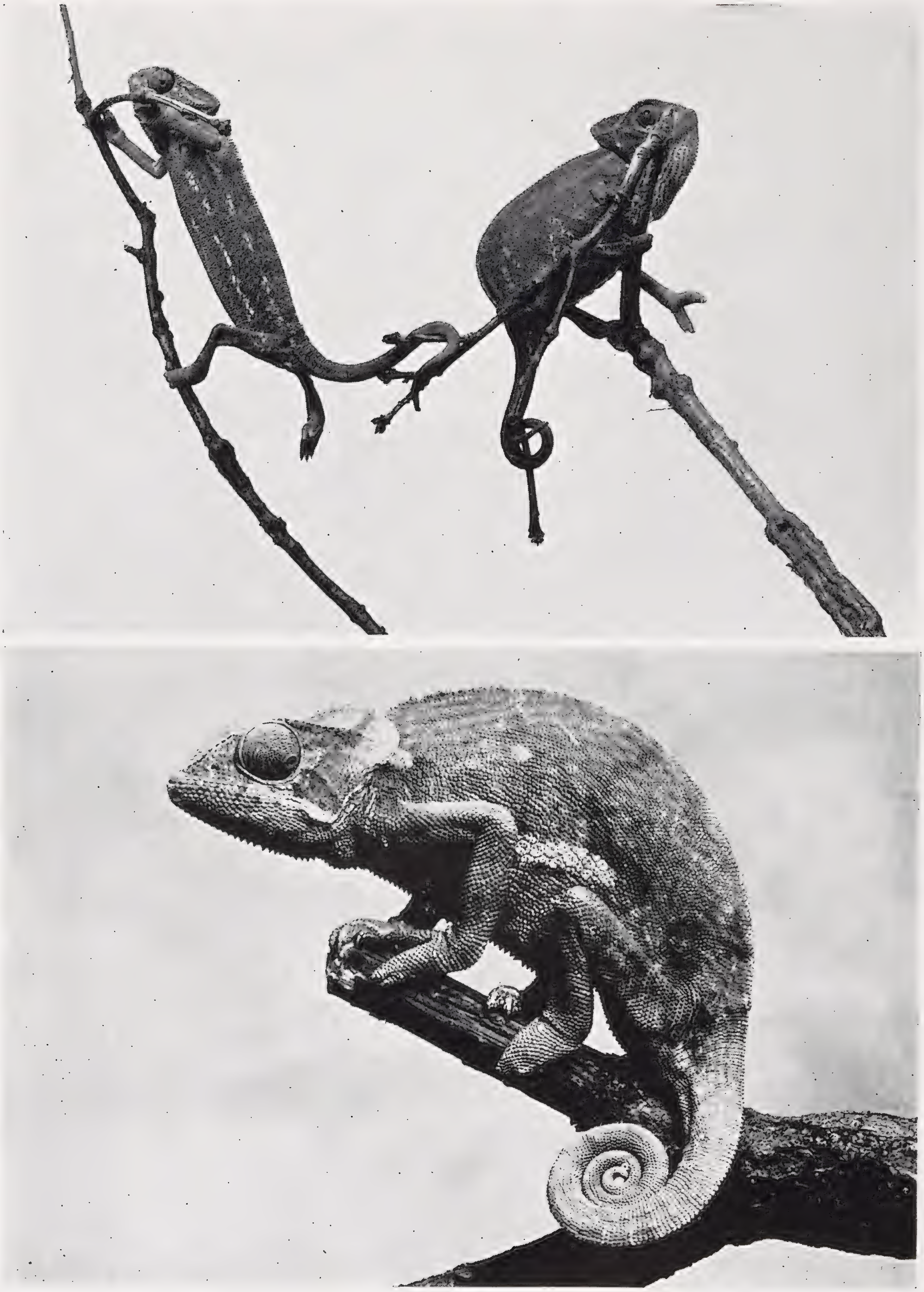


(p) Flying Dragon, *Draco volans.* Family Agamidae. There are several species of so-called "flying" lizards, these scattered among unrelated groups. Some are enabled to make scaling leaps by means of folds of skin between the limbs. The present species is highly specialized in having laterally movable ribs which expand the scaling planes. Photograph by Raymond L. Ditmars.

(q) Armed Agama, *Agama armata.* Family Agamidae. Another example of the Agamidae, indicating its similarity in parallel forms to the New World *Iguanidae.* There are several species of *Agama,* noted for their bristling scales. They live in hot and sterile areas. Lydekker. Royal Natural History.



(r) Bearded Dragon, *Amphibolurus barbatus* of the FAMILY AGAMIDAE, is the largest of this genus and ranges over nearly the whole of Australia. When alarmed or angered it spreads its spiky neck-frill and hisses very much like a snake. They are fond of perching on tree-stumps or fence posts where they bask in the sun. Photograph by Charles Barrett.



(s) Common Chameleon, *Chamaeleon chamaeleon*. Family Chamaeleontidae. There are more than fifty distinct kinds of chameleons. They are the most highly specialized among the lizards, possessing a prehensile tail, while the fingers and toes have become fused as opposable clasps to form perfect grasping organs. The eyes are remarkable in being large, rolling members, covered by tough skin, with a small opening in the center for the pupil. The eyes roll independently. The species form a distinct family inhabiting Africa, the shores of the Mediterranean and India. These lizards are noted for their remarkable changes of color. Photographs by Raymond L. Ditmars.

Recent Activities In the Department of Tropical Research

WILLIAM BEEBE

Illustrations from drawings in line and water colors by members of the Staff.

THE year 1933 was a very busy and successful one for the staff of the Department of Tropical Research. Two expeditions were undertaken, one in the yacht *Antares,* by the generosity of Colonel Chance. This lasted six weeks, and Jamaica, Panama, the Pearl Islands in the Pacific, and the Mosquito Coast were visited.

Three and a half months were spent in Bermuda, the staff boarding at the Biological Station and carrying on research at New Nonsuch, the new laboratory of the department. This is now in full working order, with an adequate building, boathouse, wharf and several acres of fields and wooded hills.

Having published the Field Book of the Shore Fishes of Bermuda, Mr. Tee-Van and I turned our attention to newly laid eggs and larvae.

When we are diving in the helmets we search for attached eggs on seaweed, in the crevices and hollows of reefs, or even inside the valves of empty seashells. But the great majority of fish eggs are pelagic, that is, they float free in the water, usually at the surface, and to secure these we draw large silk nets near the top of the water. The best time for perfectly fresh eggs is late in the evening or from four to six o'clock in the morning, for many species of fish seem to spawn in darkness. Nevertheless there is an abundance floating even at mid-day. Spring and summer are the seasons when many of the commoner shore fish breed, but at sea we found hosts of individual eggs of a large number of species, with no signs of diminishing from August to December.

The eggs are studied and described under low and high power lenses and then placed in as normal conditions as possible until hatched, when the larvae and post-larvae are watched and drawn in turn. After we bring in a large haul we have little rest, for the eggs begin developing at once and some of the smaller hatch within twelve hours after being deposited in the water.

In a short dive in the Bathysphere thirty fathoms down, I once saw parrot-fish fully four feet in length, larger than I have ever seen them near shore. As a contrast, in one of our first nets this year we caught a half dozen infant parrots measuring one-twenty-fifth of an inch in length. Only by their skeleton and other internal characters could we tell what they were, for externally they were very unlike their parents. Even their teeth were separate and not welded together in a great beak.

The eggs of eels are usually of large size, and we constantly have most interesting larvae developing before our eyes into quite unknown species. Young eels have no fewer than three sets of teeth before they acquire their final sharp armature. It is a dramatic and exciting event to watch the formation of the first two cells, and then on and on, until we detect the first beat of the heart of the tiny embryo.

Toward the end of development the infants become very restless in their diminutive, spherical cosmos, and they push and twist until at last they fracture the egg-shell wall and swim out into the world, often laden with a large mass of yolk and one or more oil globules whose buoyancy is so great that, for a time, they have to swim upside down.

The eyes and mouths of small eels are enormous, for these are most important from the moment of birth, to enable the weaklings to escape danger and to find food. The young eel passes through a stage known as leptocephalus, where he resembles an elongate, transparent leaf, and only later does he develop color and thickness, and acquire a resemblance to his parents. The excitement and interest never lessens of catching and hatching these minute fish and watching them develop one characteristic after another.

As I recently wrote in the "Field Book of the Shore Fishes of Bermuda," "Not one complete life history of a Bermuda fish is known." When we realise that there are at least six hundred species of fish near Bermuda we know that, with all our efforts, we can make only the slightest beginning on the problem.

In 1933 Miss Hollister completed much work on the skeletons of the tails of both shallow and deep water fish. The amazing economy of Nature was recently shown in a rare deep sea fish whose tail fin in life grows smaller and the upper and lower fins increase as the fish grows up. We do not need to see the fish using its tail fin less and less, for the skeleton itself reveals this change of function. As soon as the muscular swimming pressure is relaxed on the tail fin, its supporting bones become weaker and begin to disappear.

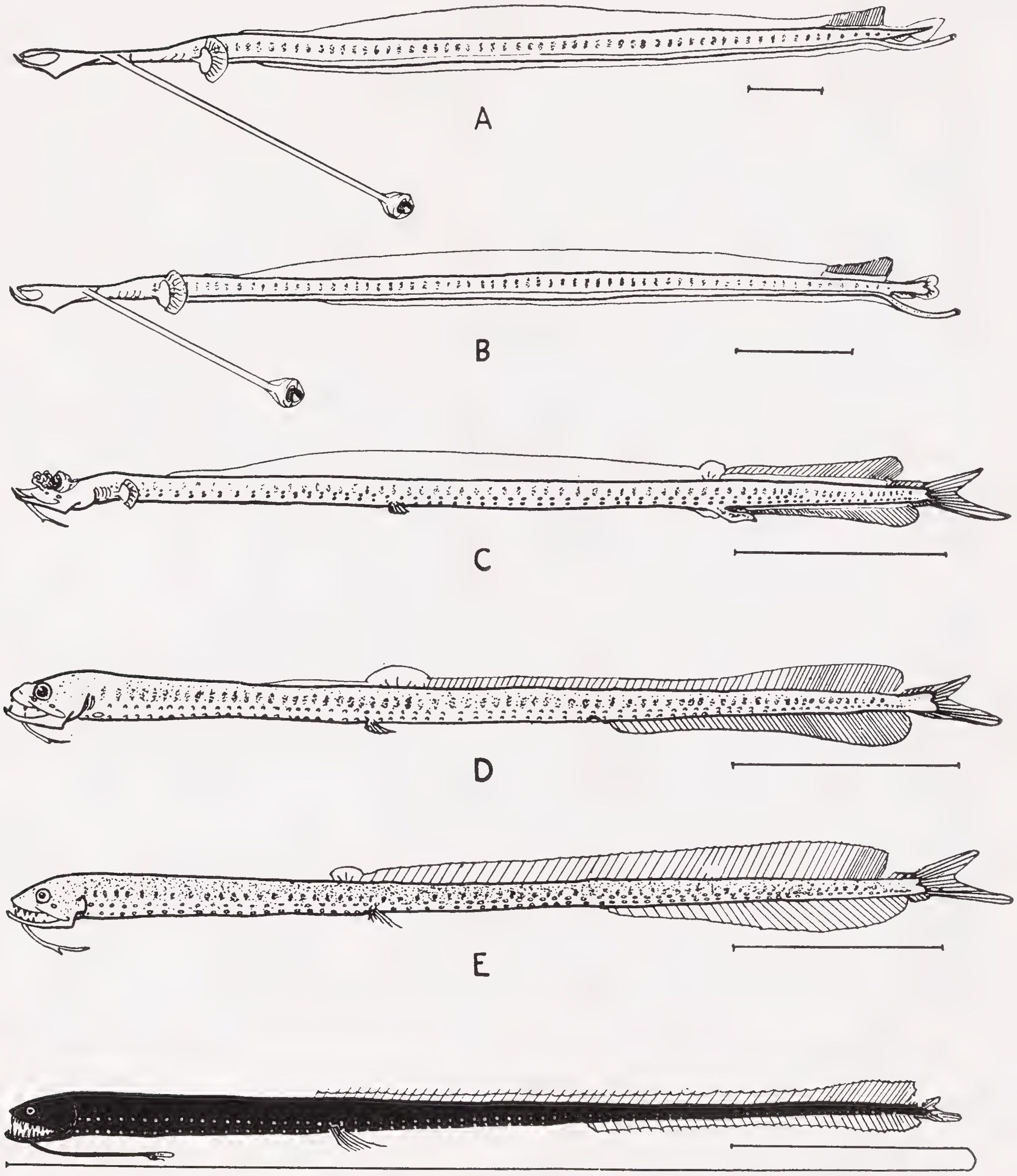
Miss Crane and I continued our studies of the deep-sea fish taken south of Nonsuch Island during the last four years, and constantly found new species and made new discoveries. One of the most unexpected has just come to light. A tiny fish with the eyes on enormously long stalks is called *Stylophthalmus* and has been placed in a special family by itself. We now find that in the course of growth the eyes are gradually pulled back again into a more normal position close to the sides of the head. Other radical changes take place and we have a complete series of specimens showing that these fish are nothing more than the larvae of *Idiacanthus,* a member of a wholly different family. In the shortening of the eyes there is absorbed not only the cartilage of the long stalk but the muscles and nerves which move and vitalize the eye. What was once the stiff cartilage stalk is finally a tightly rolled bundle which sinks into the anterior part of the eye-socket and is soon covered with skin. This is one more of the unreasonable, apparently quite unnecessary, Alice-in-Wonderland changes which characterize the weird fish living in the icy, black depths of the sea, off the shores of Bermuda.

Further study of the same creatures has revealed still more remarkable wonders. This same deep-sea fish known as *Idiacanthus fasciola,* or Gleaming-tailed Serpent Dragon, is not rare five miles off Bermuda and a mile down. We have caught over a hundred in our nets. Whenever we have examined large individuals, by which I mean those over ten inches long, they have proved to be females.

The stalk-eyed young larvae, after they have drawn in their long stalked eyes, do one of two things. They either grow a complicated barbel from the chin and a tiny, silvery-pink light beneath the eyes, or they wholly lack a barbel and develop an enormous creamy white light, blazing on each side of the head. We had great difficulty in making a reasonable, straight series of all these youngsters. Something was wrong, and they would not fall into place. Finally, we made a few careful dissections and the whole thing became clear.

The immature-looking individuals with the huge cheek lights are, most astonishingly, full-grown males. So here we have large, black, eel-like creatures with a curious leaf-like affair growing from the throat, and great yellow tail lights, which are the full-grown females, and, on the other hand, little chaps, not more than one-eighth as large as their sisters, with no functional stomach, no teeth, no paired fins, but with two enormous cheek-lights. These diminutive fish, with all their juvenile appearance, are actually the full-grown males of the species. From their weakness and small size we must consider them parasitic, but we do not know in what way.

It is as amazing as if a race of fowls should be developed, with the hens of normal size and

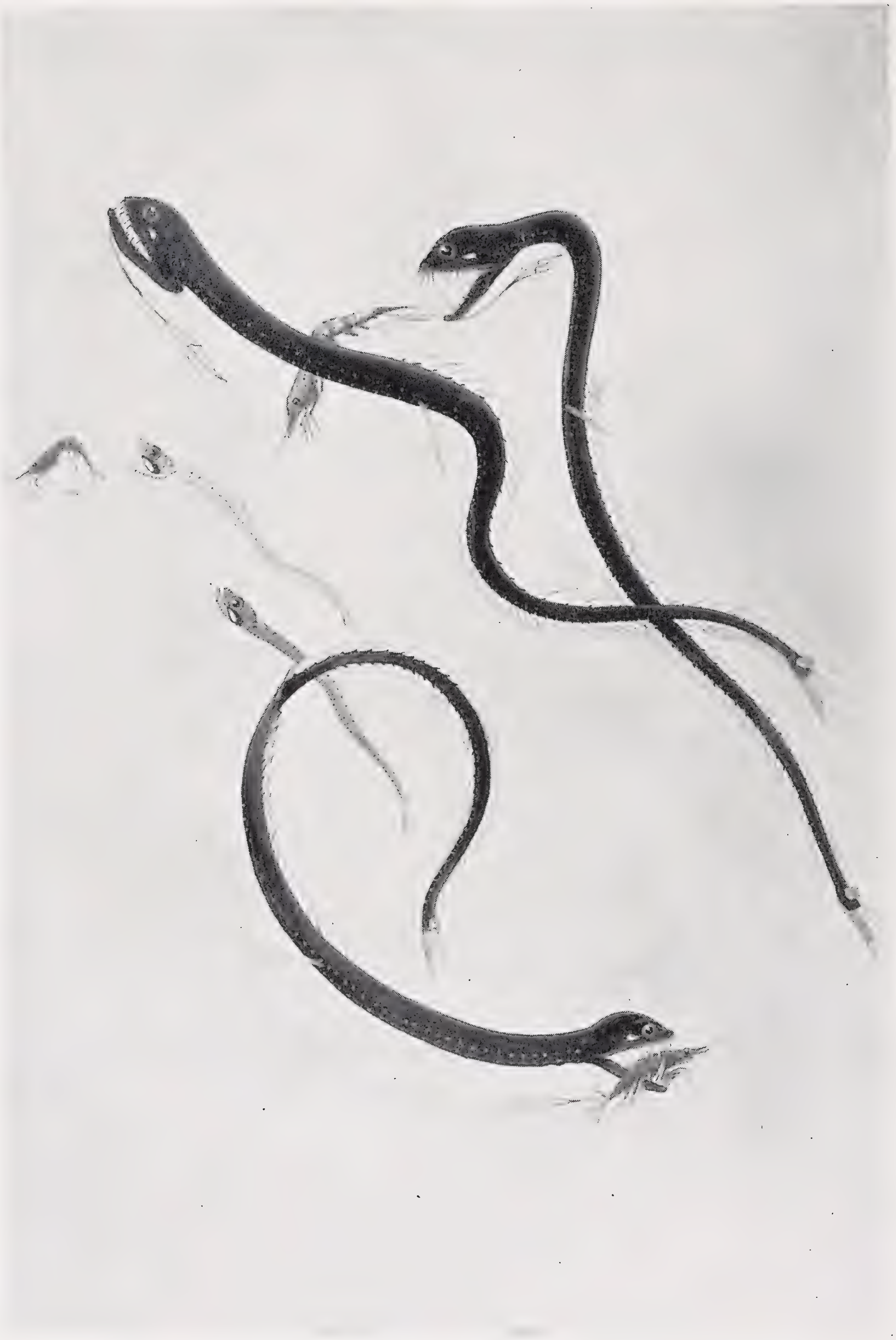


Development of the female Gleaming-tailed Sea Dragon. The larvae half an inch long, have enormous eye-stalks. These are gradually absorbed, a chin barbel and small pelvic fins appear, and the fish gradually grows darker. When full-grown, it is black and measures a foot in length.

the roosters only as large as new-hatched chicks, with down instead of feathers and a faint cheeping voice instead of a lusty crow. How the two sexes of the Serpent Dragons find one another, or how two fish of such dissimilar size can successfully mate is still to be discovered.

It seems certain that the lack of teeth and stomach in the tiny male indicates that he must not lose a moment in searching for and finding his mate, or death from starvation will claim him. That this death is probably the fate of many, seems indicated by the fact that the dwarf males outnumber the females four to one. Many must die after a vain search, while even the one successful male, still not able to feed, has only the prospect of succumbing after mating. What an opportunity for a moral!

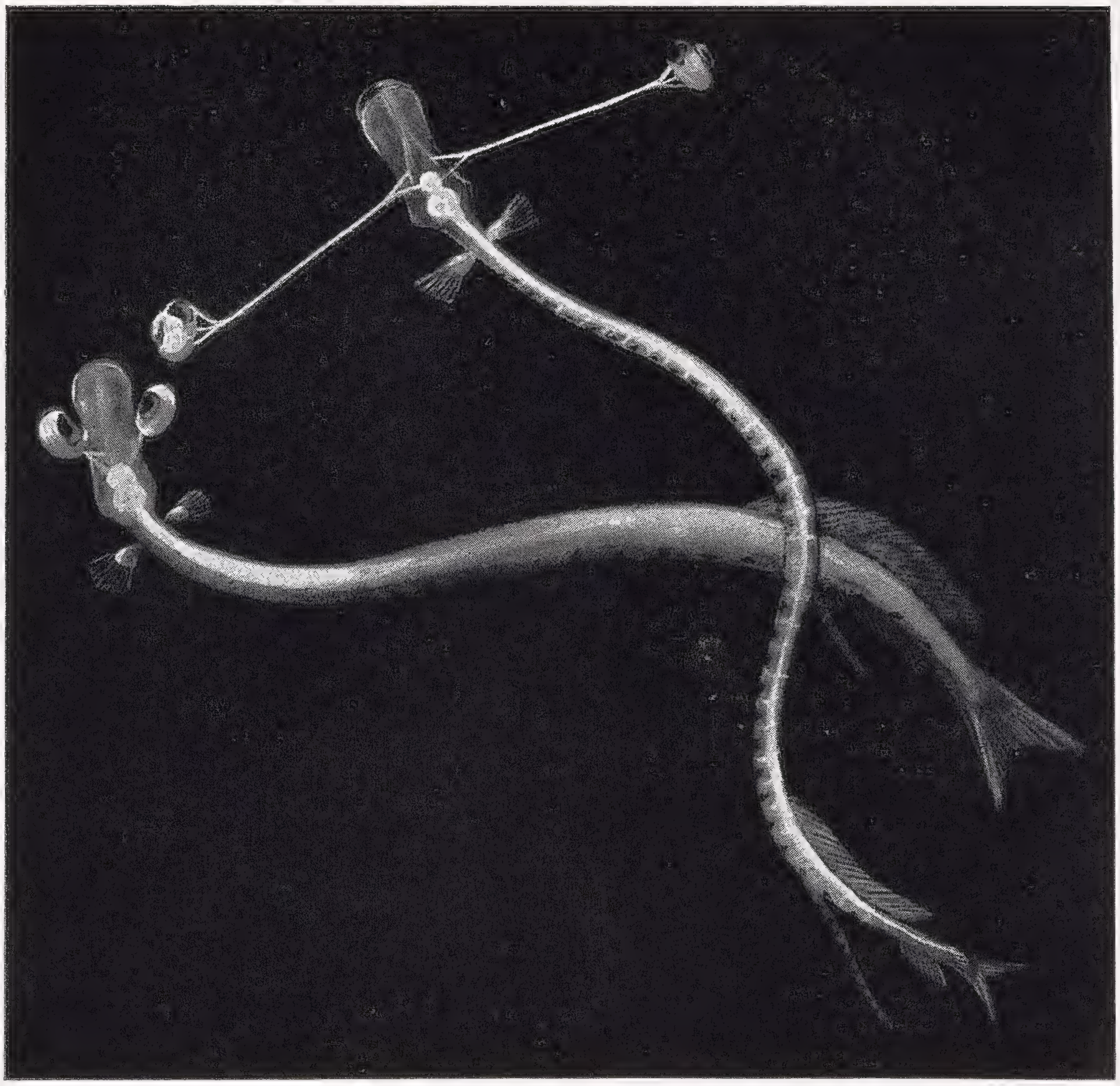
In addition to the familiar sergeant majors, slippery dicks and angel-fish of the Bermuda shallows, try to imagine, deep in the icy blackness off the shores, these Serpent Dragons swimming about—four, tiny, larva-like males ever seeking to find their single, enormous mate, gambling the carrying power of their great, yellow globes of light against the short shrift of life enforced by their lack of teeth and stomach. Why should they have to combat such handicaps?



Full-grown male and female of the Gleaming-tailed Sea Dragon. When this plate was published in the Zoological Society's Annual Report for 1932 the small fish were thought to be the young. Now we know they are adult males.

A complete, technical account of the development of this fish, *Idiacanthus,* has just been published in the Zoological Society's Zoologica, Vol. XVI, No. 4. Its life history has been considered so amazing and unique by Dr. William K. Gregory of the American Museum that a special wall case has been provided in the hall of deep sea fishes of that institution for a permanent exhibition of the original drawings, enlarged models and actual specimens of both sexes and various ages of the fish themselves.

While I never like to anticipate what is not yet accomplished, yet the first three months of 1934 adumbrate a season of real achievement. The most important event is the offer of the National Geographic Society to set aside a fund



The larvae and post-larvae of the Gleaming-tailed Sea Dragon, showing how the long-stalked eyes shrink into more normal positions.

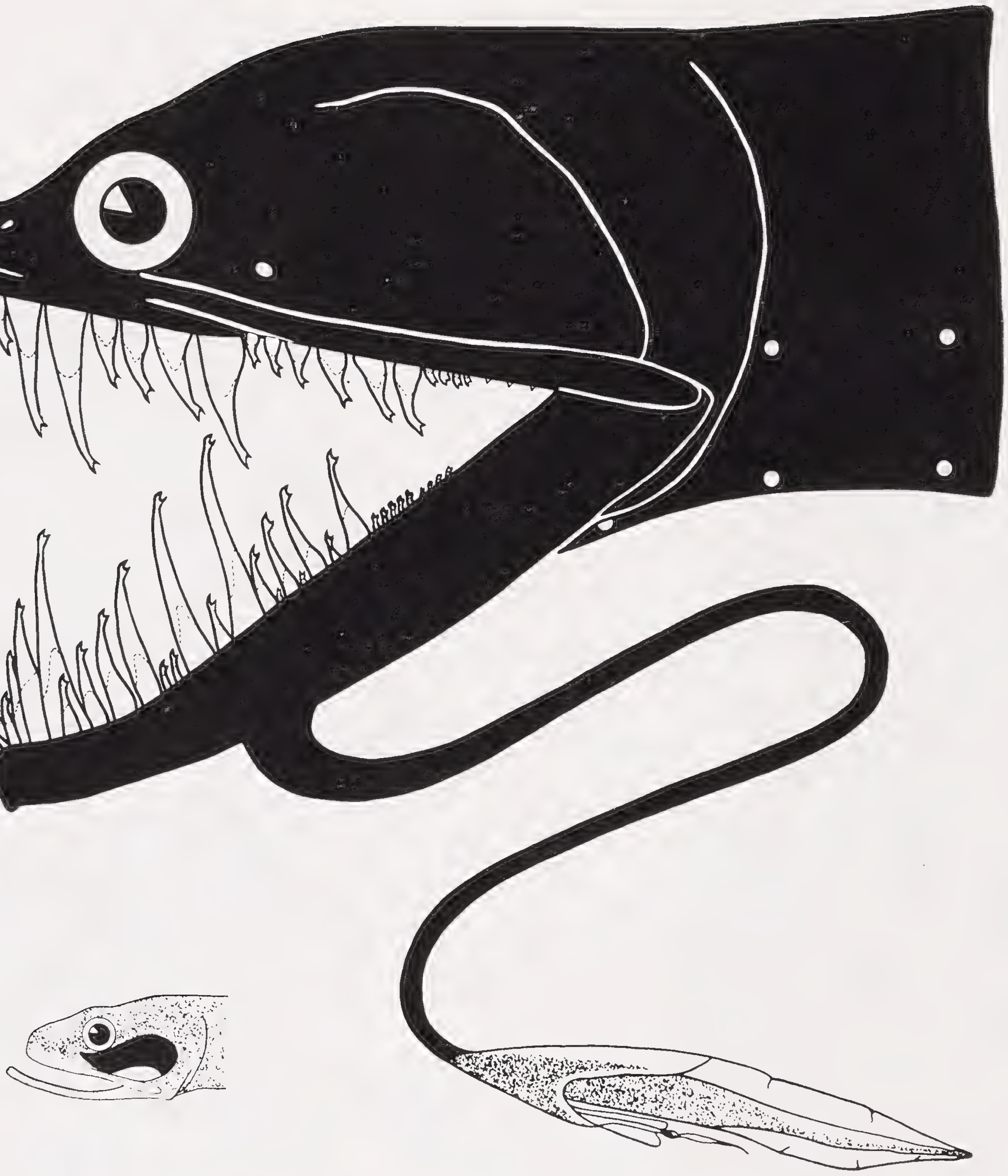
sufficient for another Bathysphere dive. This has been accepted by the Zoological Society, so this season will see two expeditions, one within the other. The Nineteenth of the Department of Tropical Research is to be called the National Geographic Society—William Beebe Expedition. This will be concerned with the actual dives of the Bathysphere and a series of deep-sea trawls from our old tug, the *Gladisfen*. These will take place during July or August, the calmest months of the year. The Twentieth Expedition of the Department will be under the direct auspices of the Zoological Society, and will begin in May in Bermuda at the New Laboratory, and continue until the autumn.

The Bathysphere, which has been at the Century of Progress Exhibition in Chicago throughout 1933, has been brought east to the factory where it was made, the Watson-Stillman Company of Roselle. Here it is being thoroughly overhauled and reconditioned by Mr. Stillman.

Kind friends have turned up on all sides, to aid in the preparations for the new dive. The Air Reduction Co. is assembling and presenting the Department with the most efficient type of oxygen apparatus, including new tanks and valves, chemicals and an electric fan for driving air through the carbon dioxide and humidity absorbers. The Bell Telephone Co. is placing the phones used in 1930 and 1932 in their museum and giving us a complete new set. We are purchasing six hundred additional feet of telephone and electric light hose.

The General Electric Company, through the kind offices of Mr. Owen D. Young and Mr. Gerard Swope has promised, as a gift, three new windows of fused quartz.

The results of all this will be that, wind and water permitting, I will be able to reach a depth of quite three thousand feet, and remain below the surface for four hours or more. Thus the hurry and the incomplete observations of former



Heads of the full-grown male and female Gleaming-tailed Sea Dragon. The male is very tiny, pale grayish-white, toothless, lacks paired fins and has an enormous cheek light. The female is relatively gigantic, jet-black, with only very small light organs, an elaborate chin barbel, and many great, curved fangs.

dives will be done away with. It is hoped we will be able to see in detail more of the inhabitants of these unknown regions.

An entirely new field of work this year is an elaborate stop-microcamera, intended to record the complete development of the fish eggs such as we found last year.

The regular staff of the Department will be in the field throughout the expeditions. Mr. Otis Barton is expected in June, in time to join the Director in the deep dives, and two graduates of Dartmouth College, Perkins Bass and William Ramsey, will be with the expedition from June on.

Two artists will accompany the expedition. One of these is George Swanson. The other is Mrs. Bostelmann whose splendid colored paintings of deep sea life are so well known to members of the Zoological Society.

Postscript to "On the Antares to the West Indies" in the last number of the Zoological Society Bulletin: On page 101 of the July-August Bulletin, I reproduced a memorial from the wall of the little church at Bottom, on the island of Saba. This told of four men of the name of Simmons who met their death in a storm in September, 1918. The perils of life of the brave people of this bleak-cliffed islet are emphasized by a letter I have just received from a Miss Simmons, now in the United States. She tells me that the four men were her uncles and cousins, and that shortly after this tragedy her father and two brothers were lost in a storm when on their way from St. Vincent.—*William Beebe.*

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-six volumes completed. Volume XXXVII in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Present Day Mammals (Leister); 74 pp. 105 ills.
Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
Sea Shore Life (Mayer). *Out of print.*
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend). *Out of print.*
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger). *Out of print.*
Gaff-topsail Catfish (Gudger). *Out of print.*
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 text figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs.

Post-cards: General Exhibits. Sets (12) colored.
Post-cards: Tropical Fresh-water fishes. Sets (12) colored.

For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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BULLETIN NEW YORK ZOOLOGICAL SOCIETY

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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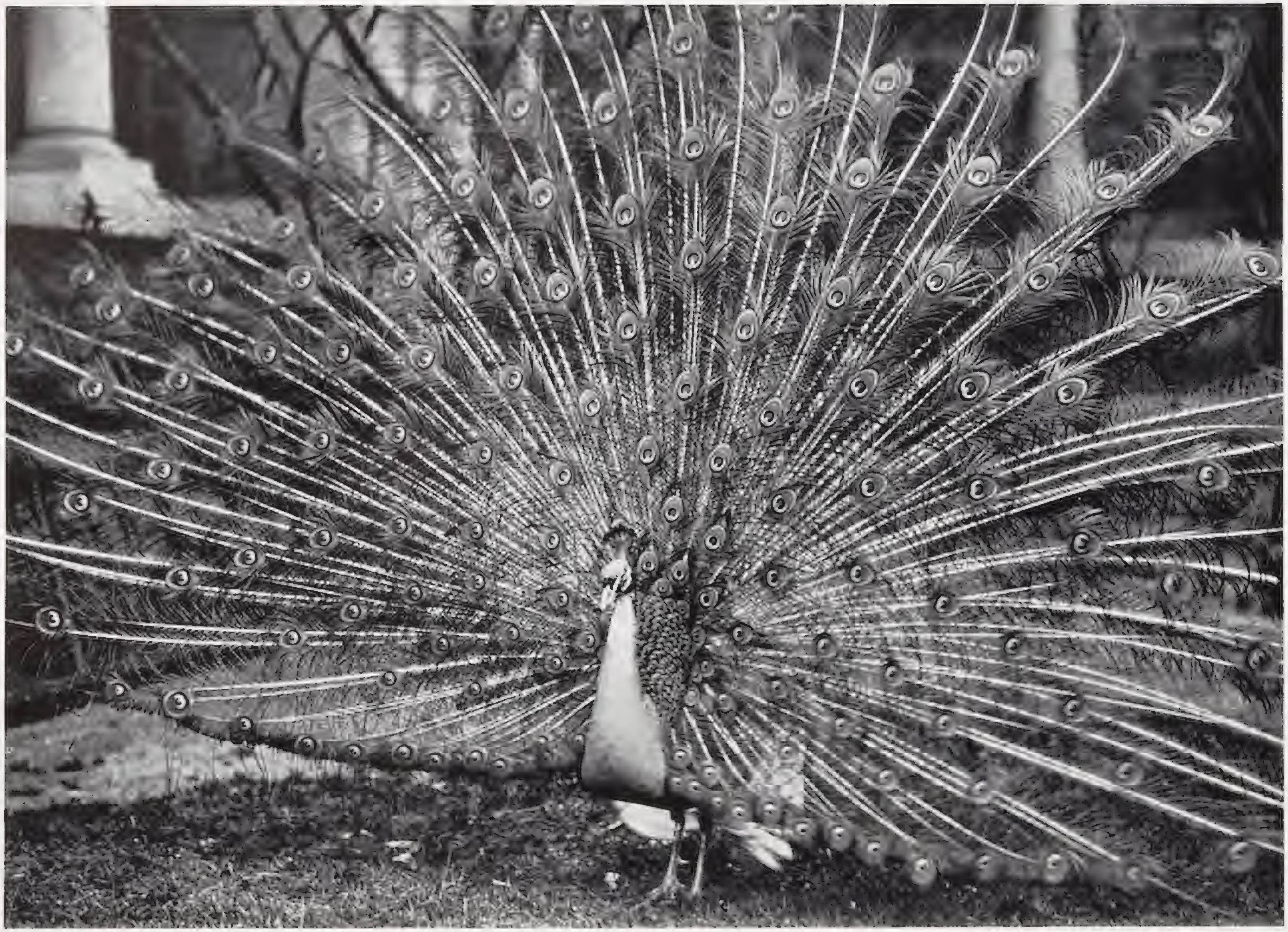


The dazzling blue of the peacock's breast, backed by the delicate tracery of the spread train, is one of the most amazingly beautiful sights to be found in nature. The bird shown is an Indian peafowl (*Pavo cristatus*). *Pavo* is Latin for "peacock" and *cristatus,* also from the Latin, means "crested." Photograph by Elwin R. Sanborn.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

Vol. XXXVII July-August, 1934 No. 4

Peafowls in the Zoological Park

Presented pictorially from the specimens in the collections of the Society, with a brief introduction by Lee S. Crandall, Curator of Birds.

All illustrations are from photographs taken in New York Zoological Park.

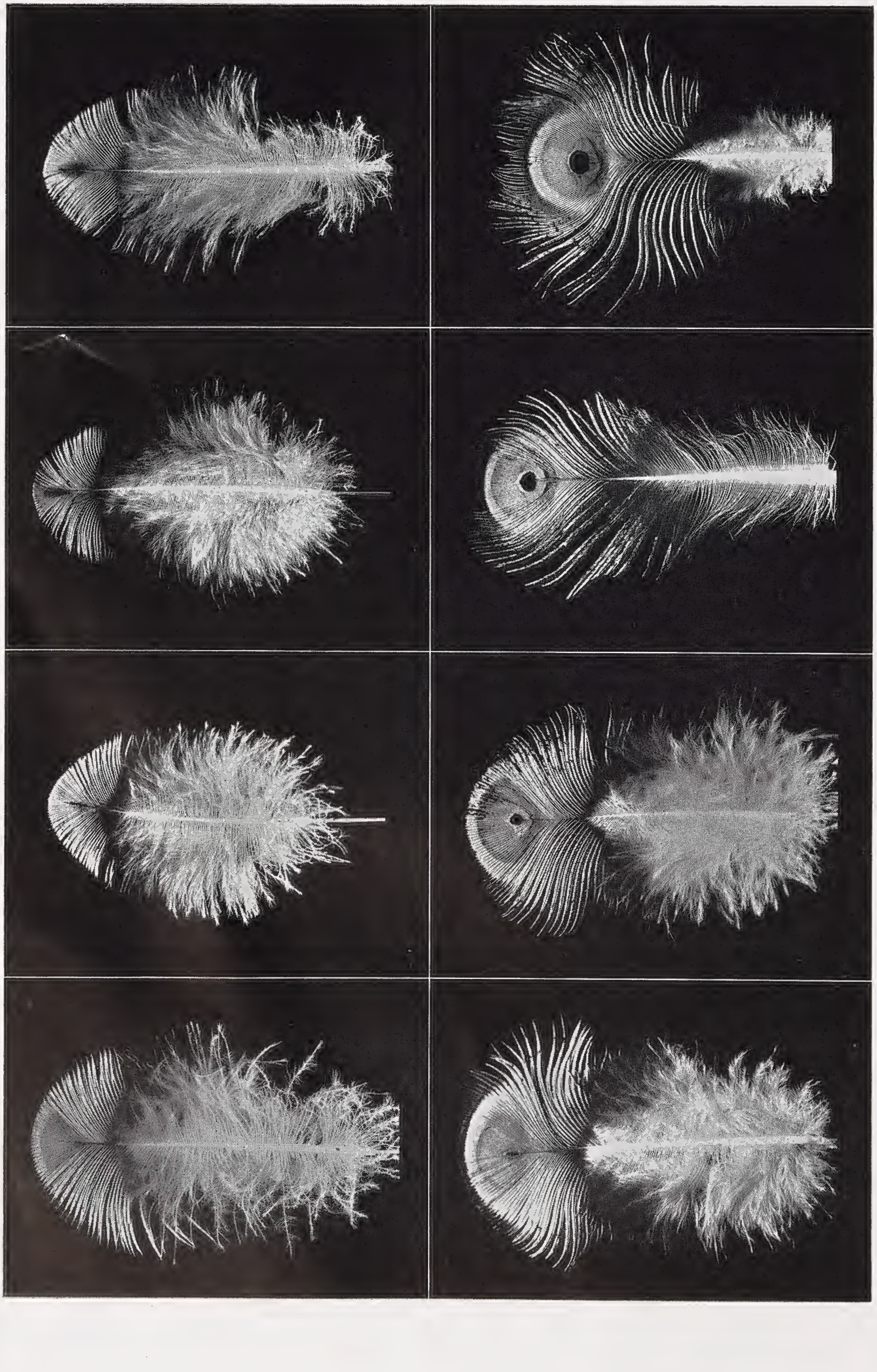
SOLOMON is credited as the first owner of peafowl outside of India. If this is true, it is quite in line with his reputation for acumen. In appreciation of the beauty of this king of birds, the ages have followed his judgment. The readiness with which peafowl have accepted the conditions of captivity, in all parts of the world and in all kinds of climate, has made them so common as to cloud our appraisal somewhat. But the fact remains that it is difficult to find a bird to excel them in beauty of form and coloration.

There are two species of peafowl: the Indian or blue (*Pavo cristatus*) and the Javan or green (*Pavo muticus*). They belong, of course, to the order *Galliformes,* and to the family *Phasianidae.* In the matter of subfamilies, authorities differ. It has long been customary to assign the peafowl to the *Pavoninae,* but in Volume II of Check-List of Birds of the World, published in June, 1934, James L. Peters places them in the subfamily *Phasianinae,* which also includes the Old World partridges and quails, the pheasants and the jungle fowl.

The Indian peafowl is a native of India and Ceylon. It keeps to the low country, seldom going above 2,000 feet. Although it is naturally accustomed to the steaming heat of such localities, it nevertheless has the ability to endure, without discomfort, temperatures well below zero Fahrenheit. It is this adaptibility which has allowed the bird to be enjoyed in most countries of the world. The male Indian peafowl is characterized by the deep blue neck and breast, the long, delicate and wonderfully "eyed" train formed by the upper tail coverts, and the fan-like crest on the head. The female is a dull gray in general, with the neck and upper breast iridescent green.

Besides the typical bird, there are three well-known color varieties: the Black-shouldered, the White and the Pied. By many, the Black- shouldered is considered as even more beautiful than the parent form. In the male, the smudgy black and white of the wing coverts of the ordinary peacock are replaced by intensely iridescent black. The blue of the neck and breast, also, appear to be of a deeper shade. Strangely, the female of this melanistic variation is nearly white, with rufous nape and dark edgings and mottlings on the feathers of wings and tail. This form is generally accepted as a mutation or sport. The white, of course, is an albinistic variety, now well established in captivity. The pied results from an infusion of white blood into the normal bird, patches of white appearing, most generally, on the throat and in the wings.

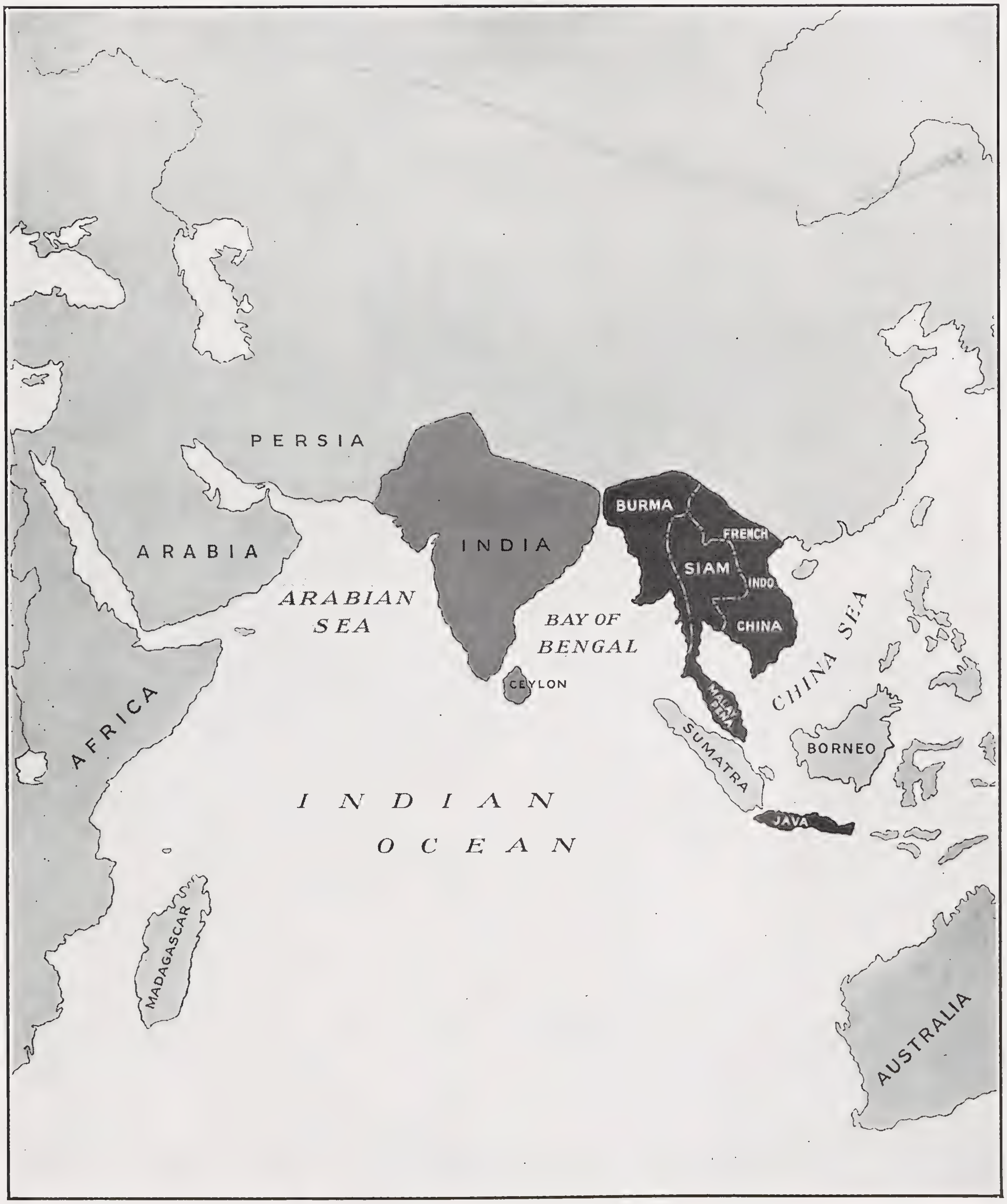
The Javan or green peafowl is quite distinct from the Indian species, and hails from Burma and Siam, through Cochin China and the Malay Peninsula to Java. The Burmese bird has been separated as *Pavo muticus speciferus,* but the distinction is slight and is not recognized by many authorities. The Javan peafowl is chiefly distinguished by the brilliant green of the neck, which has the appearance of being scaled, and the long, lance-like crest, as opposed to the fan



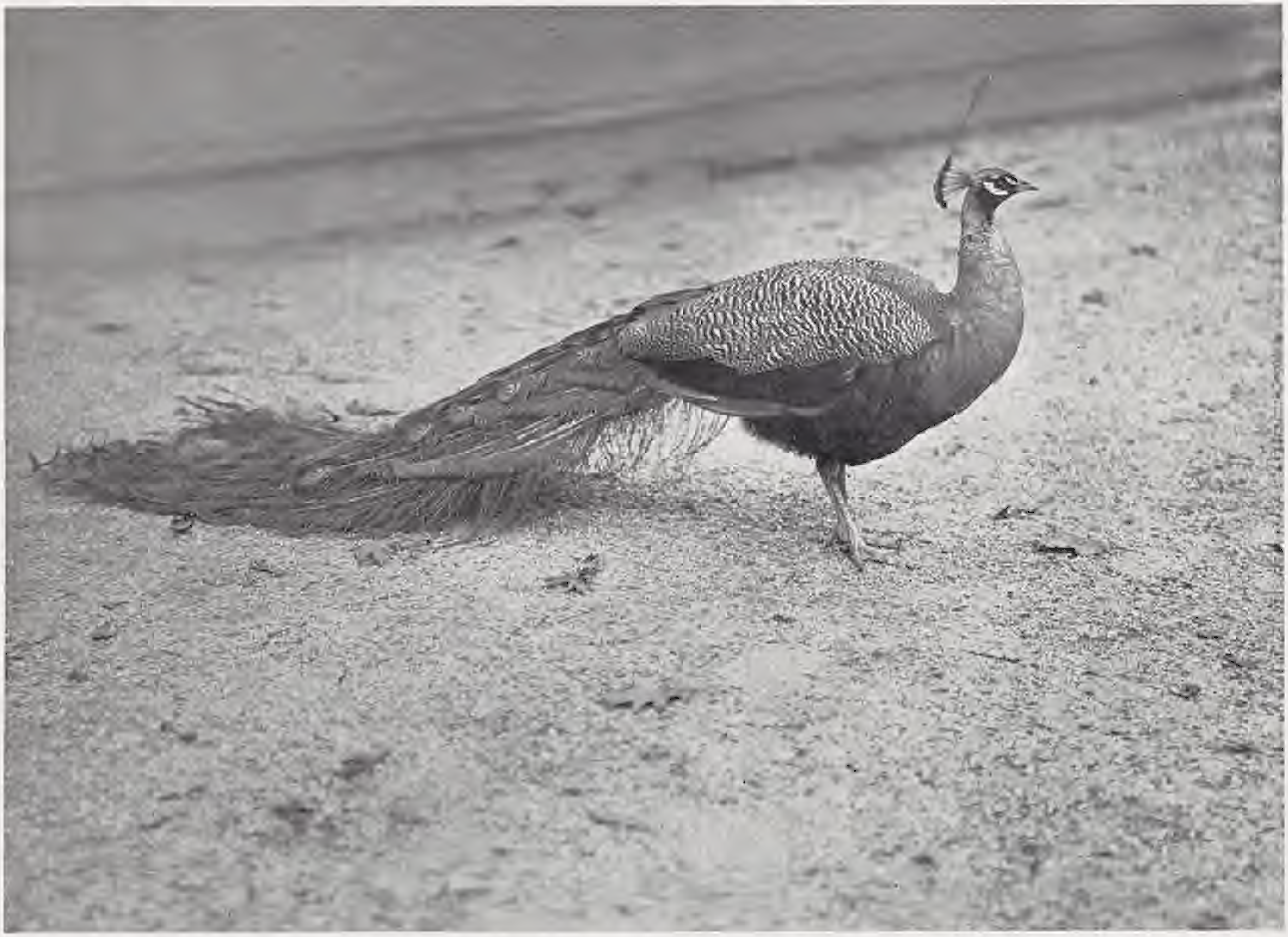
The brilliant "eyes" of the peacock's train begin to appear in the lower back and reach their perfection of size and beauty in the longer feathers. The series above illustrates varying degrees of development of this characteristic feature. Photograph by Elwin R. Sanborn.

of the Indian. In the Javan, the female is as brilliantly colored as her mate, lacking only the long train. Many females are spurred, as well, so that among young birds or during the molting season, the sexes are not always easily distinguished. There is, however, a character which seems to be infallible: a small, isolated patch of velvety feathers just before the eye is always iridescent green in males and dull brown in females.

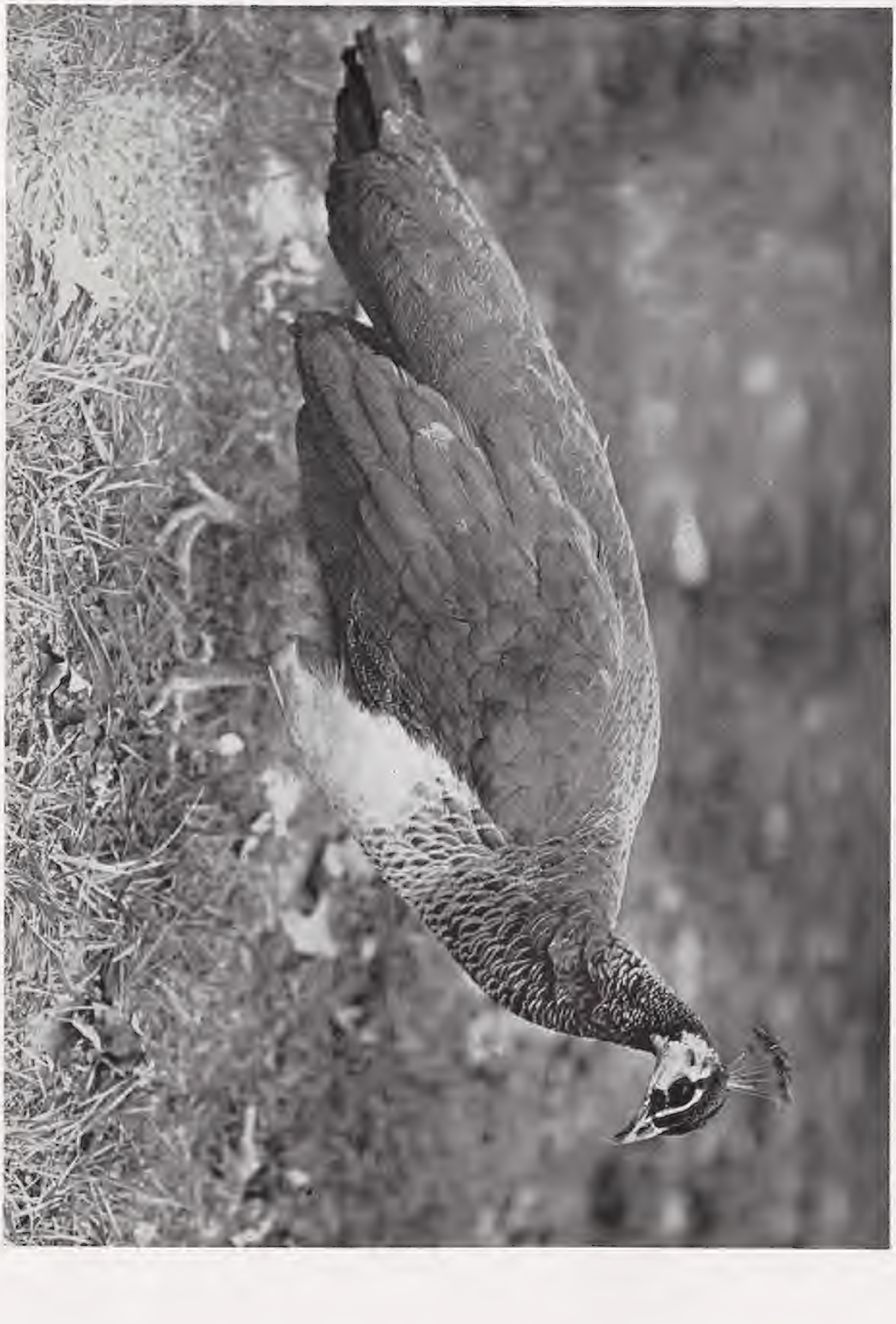
The Javan peafowl is a more delicate species than the Indian and less able to withstand low temperatures. Another characteristic which has interfered somewhat with the popularity of the species is the savageness of adult males which, in some instances, may be really dangerous.



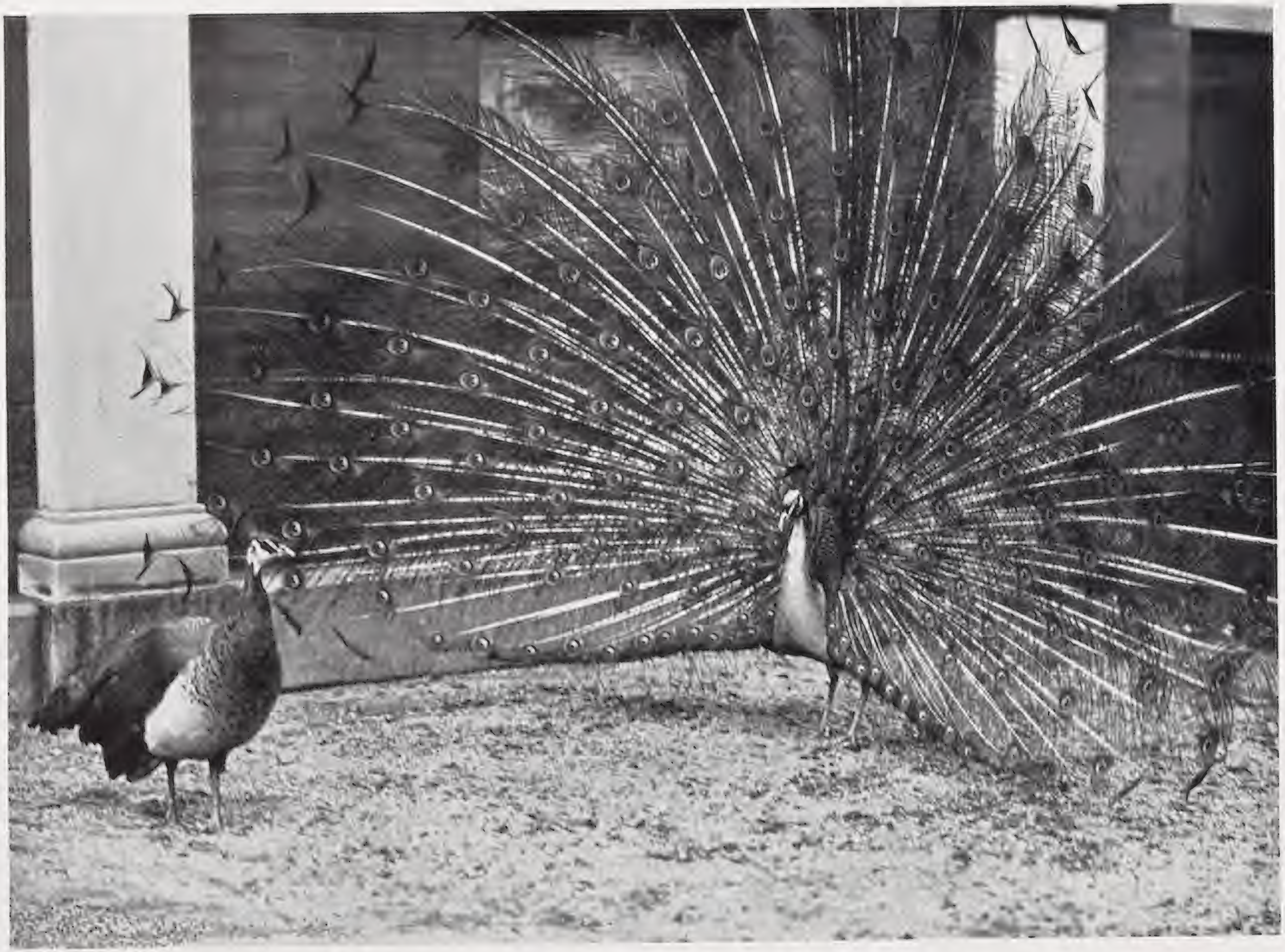
The map above illustrates the distribution of the two species of peafowl. The Indian (*Pavo cristatus*) is found in India, including the foothills of the Himalayas, and in Ceylon. The general area is indicated in medium gray. The Javan peafowl (*Pavo muticus*) comes from Burma (excepting the extreme northerly portions), Siam, Cochin China or French Indo-China, and southward through the Malay Peninsula to Java, missing Sumatra entirely. The range of this species is printed in dark gray.



Adult male Indian peafowl (*Pavo cristatus*) in repose. The long train is compactly folded, so that it causes little hindrance to its owner in escaping from its natural enemies, either by running through grass or brush, or by flight. Photograph by Elwin R. Sanborn.

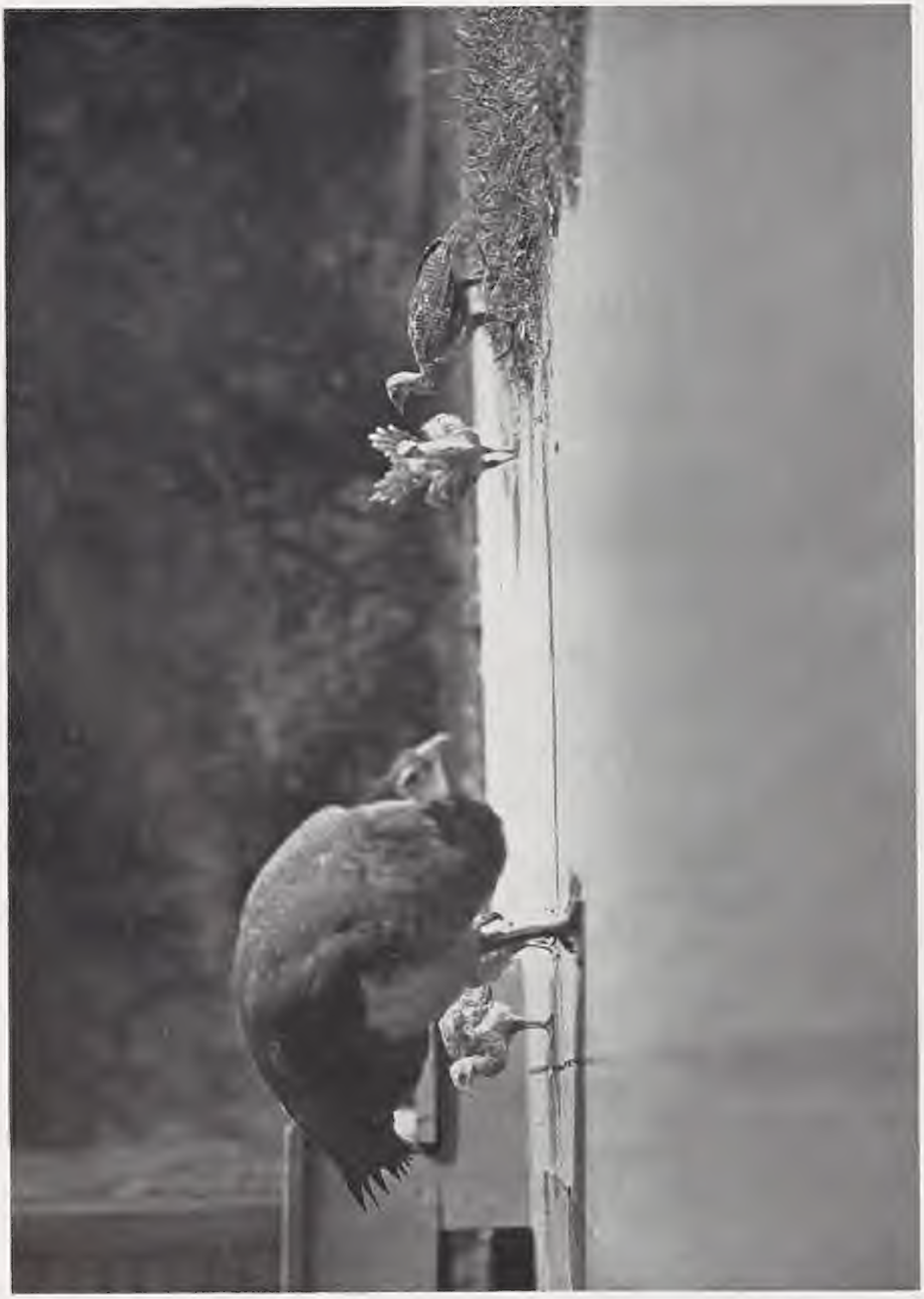


Adult female Indian peafowl (*Pavo cristatus*). Peahens of this species are dull brownish gray in general, with the neck and upper breast pale green and the lower breast light. The crest is shaped like that of the male.
Photograph by Elwin R. Sanborn.

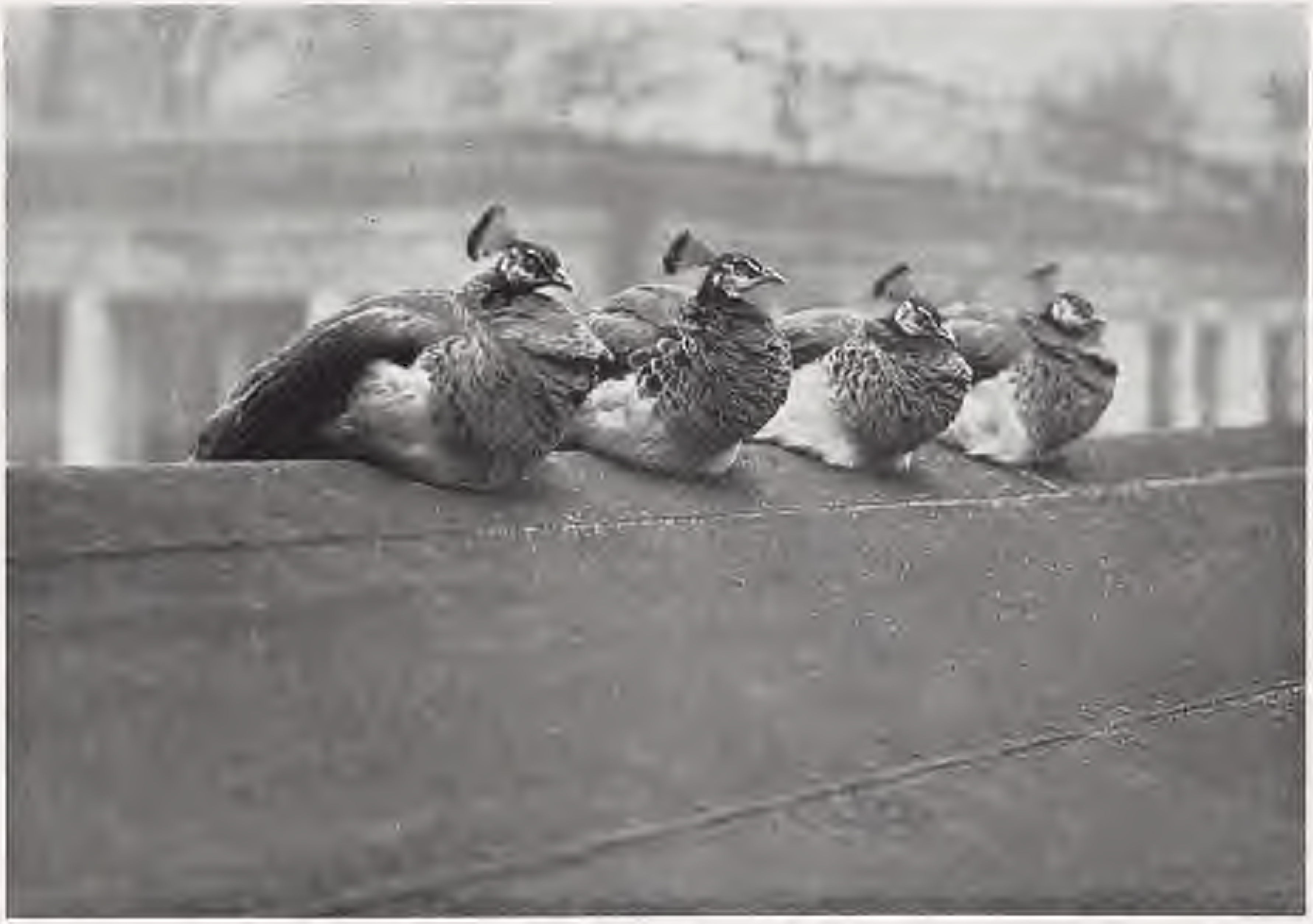


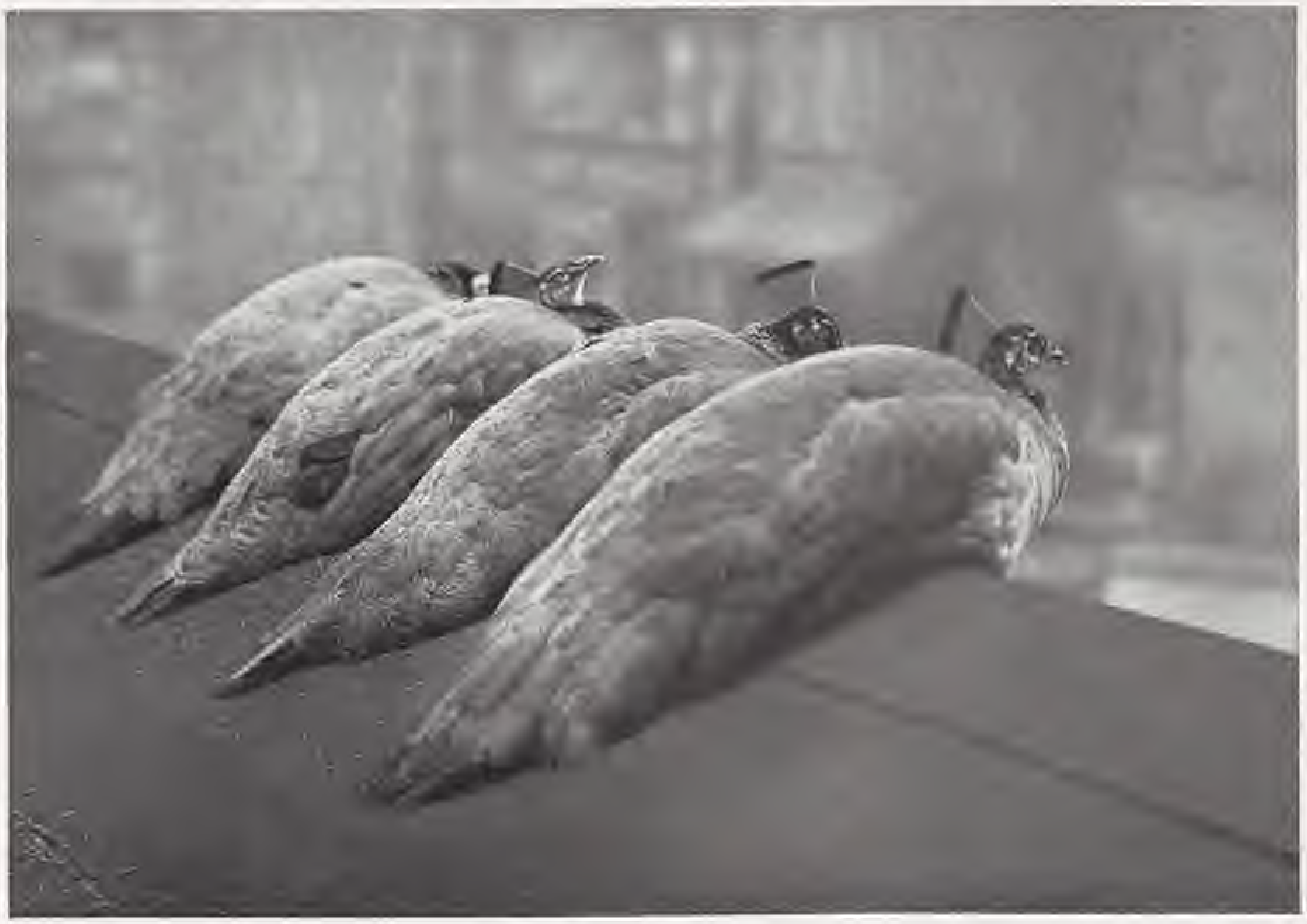
Indian peacock displaying to female. The indifferent attitude of the peahen is typical of that of most female birds toward courting males. Nevertheless, the primary purpose is served, for it is the first step in the reproductive cycle. Photograph by Elwin R. Sanborn.

Upper. Indian peahen on her nest. As a rule, peahens do not lay until late spring or nearly summer. For nesting sites, they seem to prefer tall grass or weeds, in a fairly open situation, rather than the dense cover of heavy shrubbery. *Lower*. Eggs of Indian peafowl. When hens are at liberty and allowed to nest where they please, normal clutches appear not to exceed eight. However, if the eggs are collected as laid, a far greater number may be produced. Photographs by Edward R. Osterndorff.



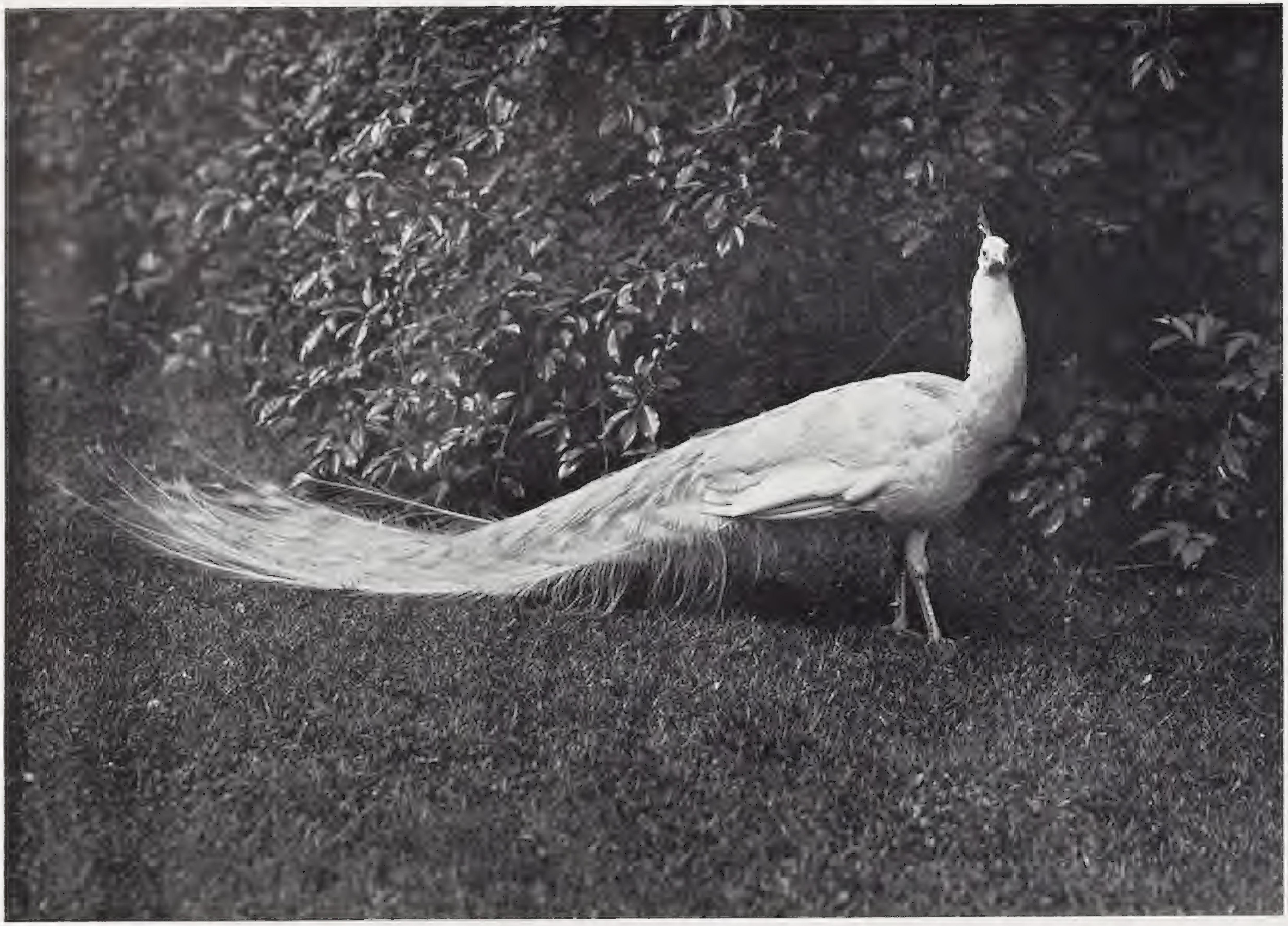
Indian peahen with chicks about six weeks old. The incubation period is twenty-eight days. The wings of newly hatched chicks are well developed and they are able to fly within a few days. A precocious young male in the picture above is already testing his ability as a charmer. Photograph by Edward R. Osterndorff.



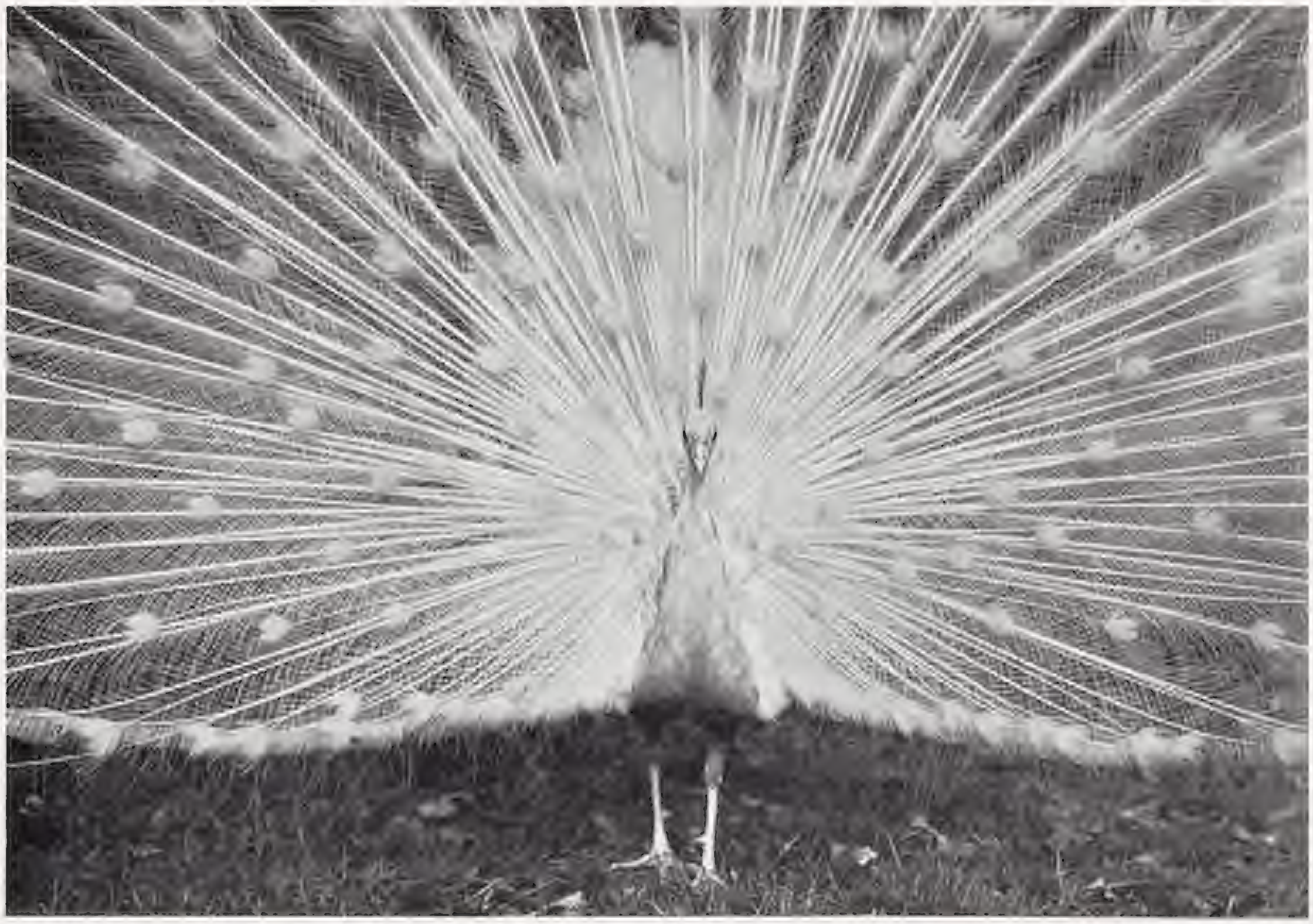


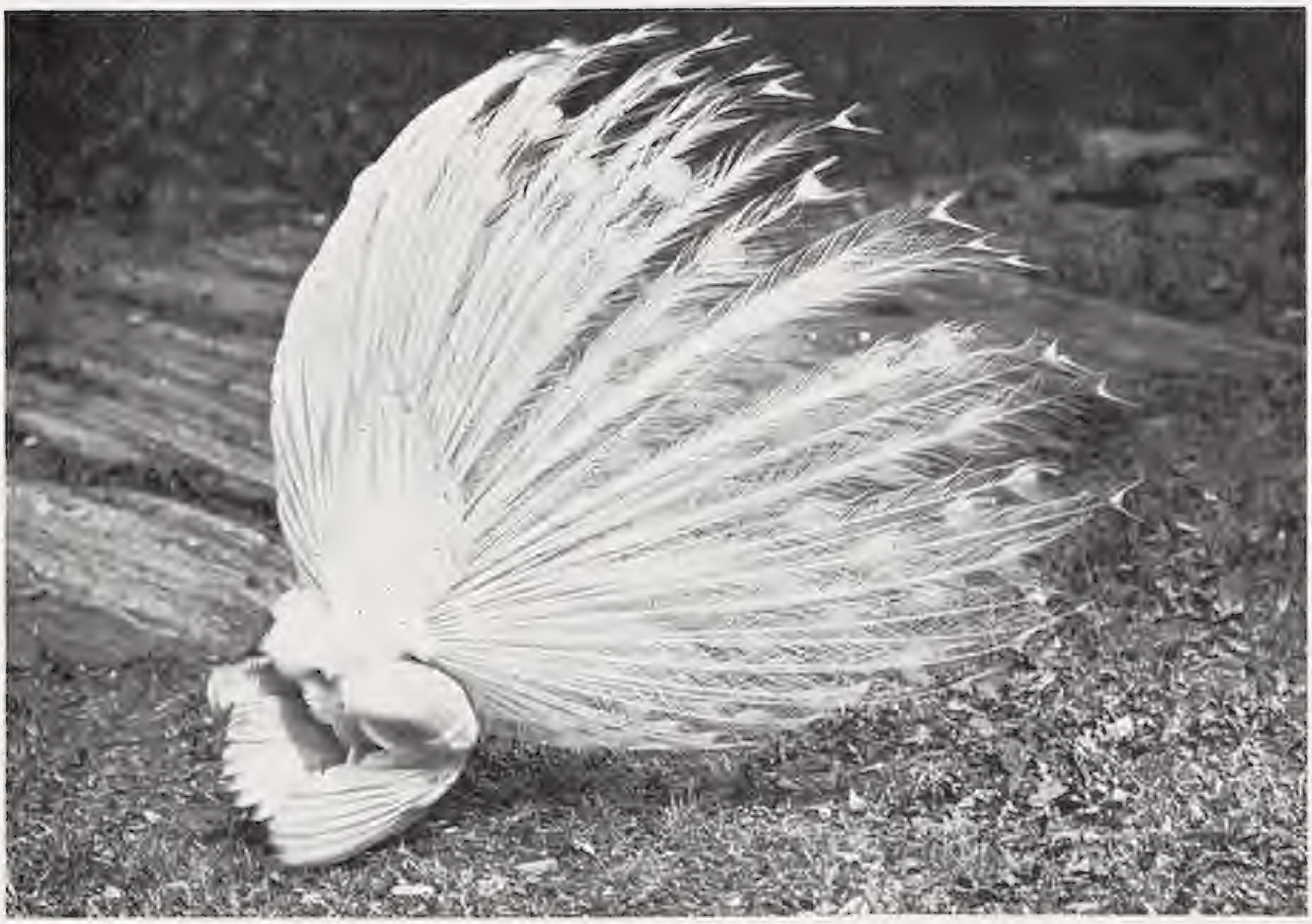
Upper. Indian peahen with her nearly full-grown brood. Peahens are excellent mothers and remain with their broods throughout the first winter. *Lower.* Another view of the same family, the mother being the bird in the foreground. Even before this advanced stage has been reached by the chicks, the males are distinguishable by the blue cast of neck and breast, as compared with the pale green of the females.

Photographs by Edward R. Osterndorff.

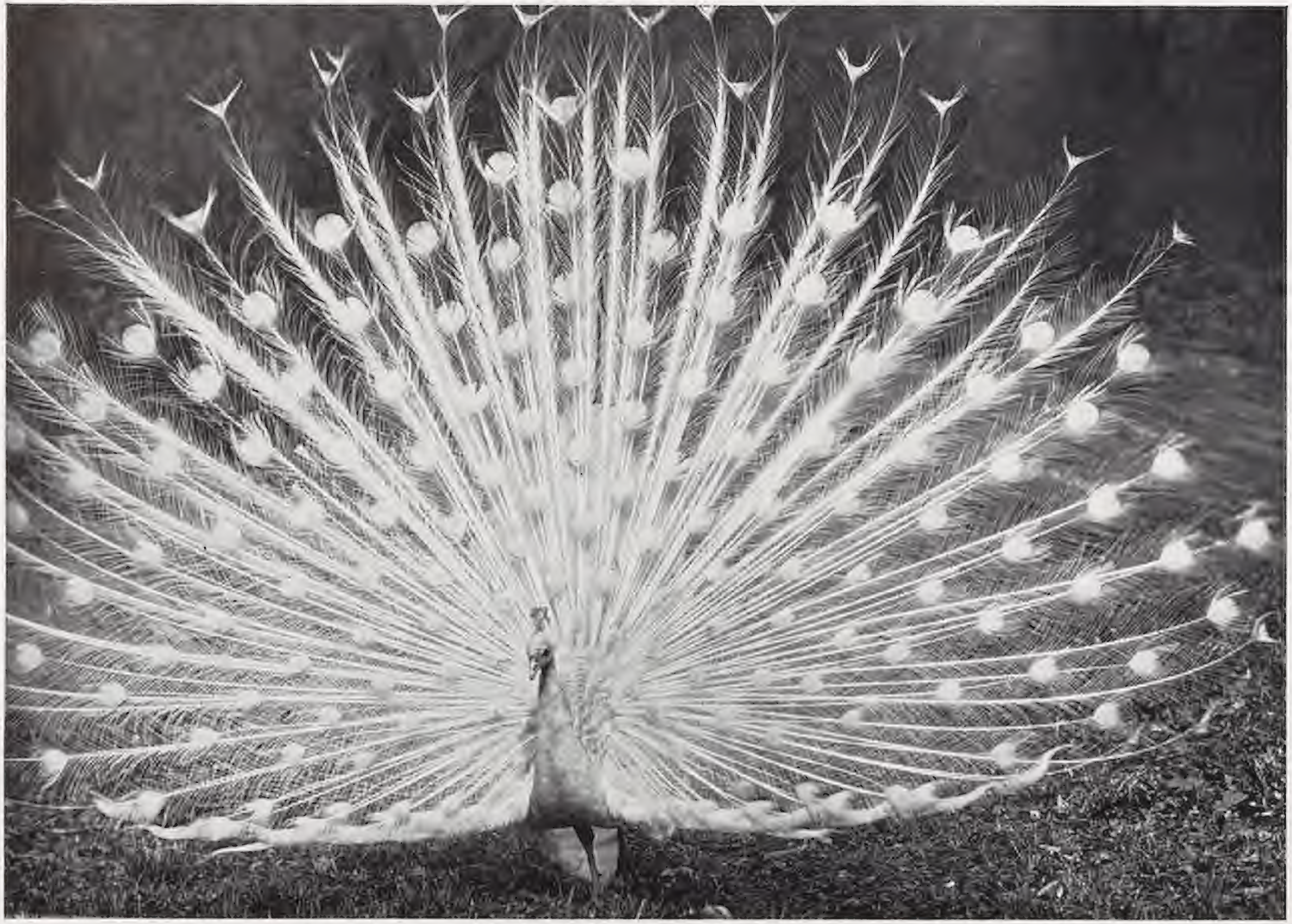


Male white peacock in full plumage. The white peafowl is simply an albinistic variety of the Indian bird, now well fixed and freely bred in captivity. Photograph by Elwin R. Sanborn.

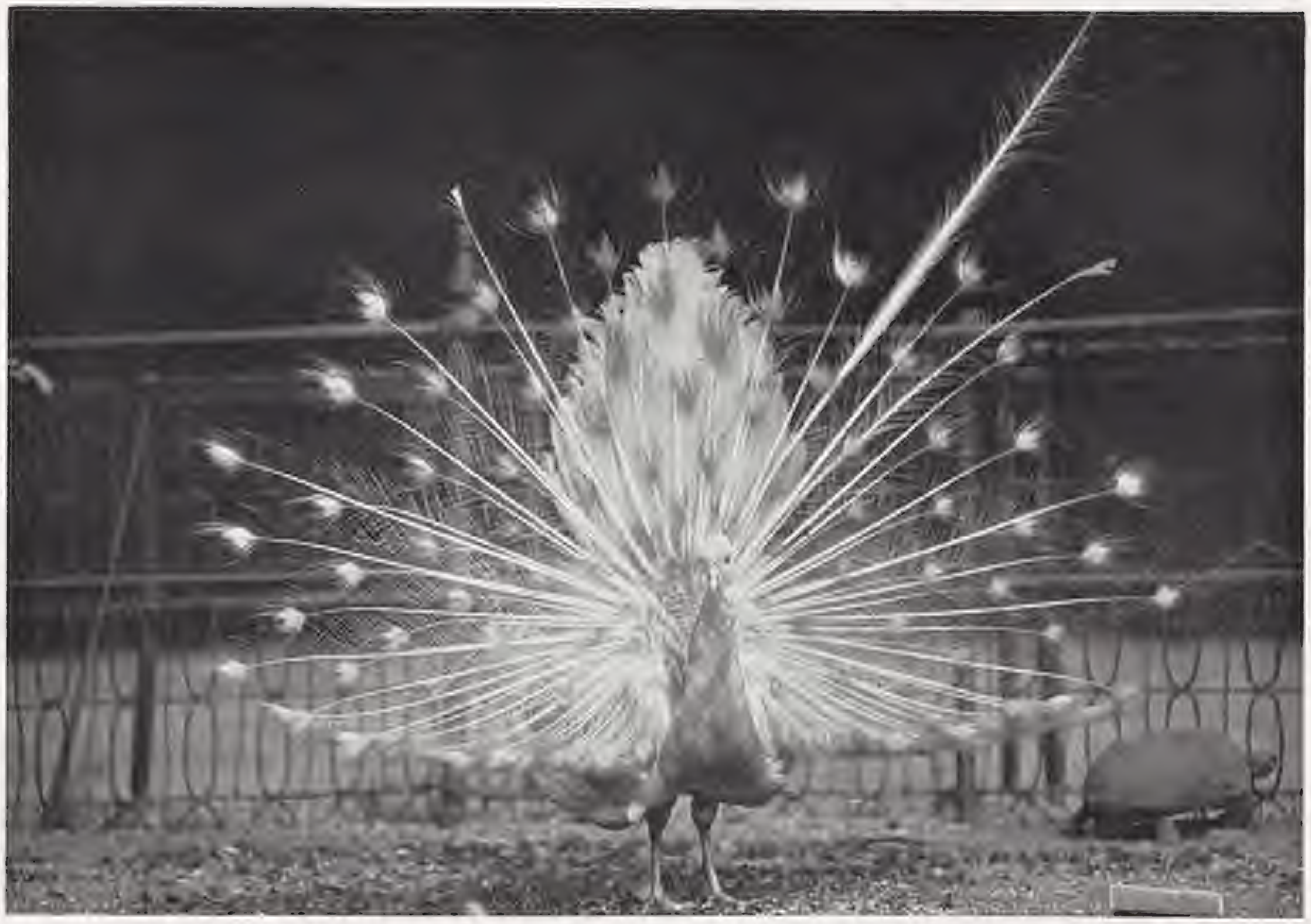


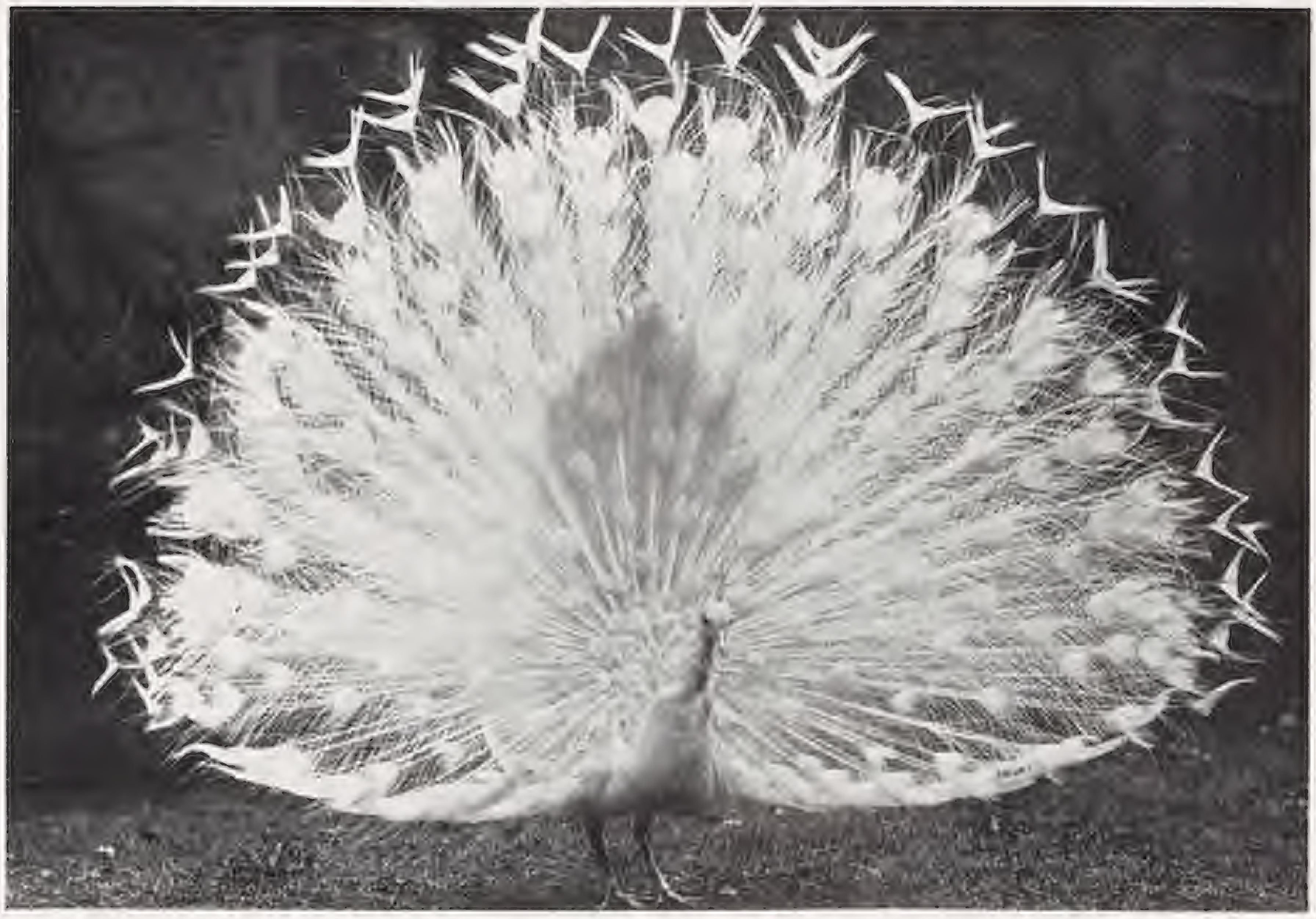


Upper. Close view of white peacock in display. The brilliant hues of the colored cock are due chiefly to the reflection of light by highly specialized feather surfaces. Close examination discloses the presence of shadow "eyes" in the white cock's train. Photograph by Edward R. Osterndorff. *Lower.* A displaying peacock is not easily discouraged but a high wind does make life rather difficult for him. This bird is battling valiantly to hold his train erect and at the same time to maintain his balance. Photograph by Elwin R. Sanborn.

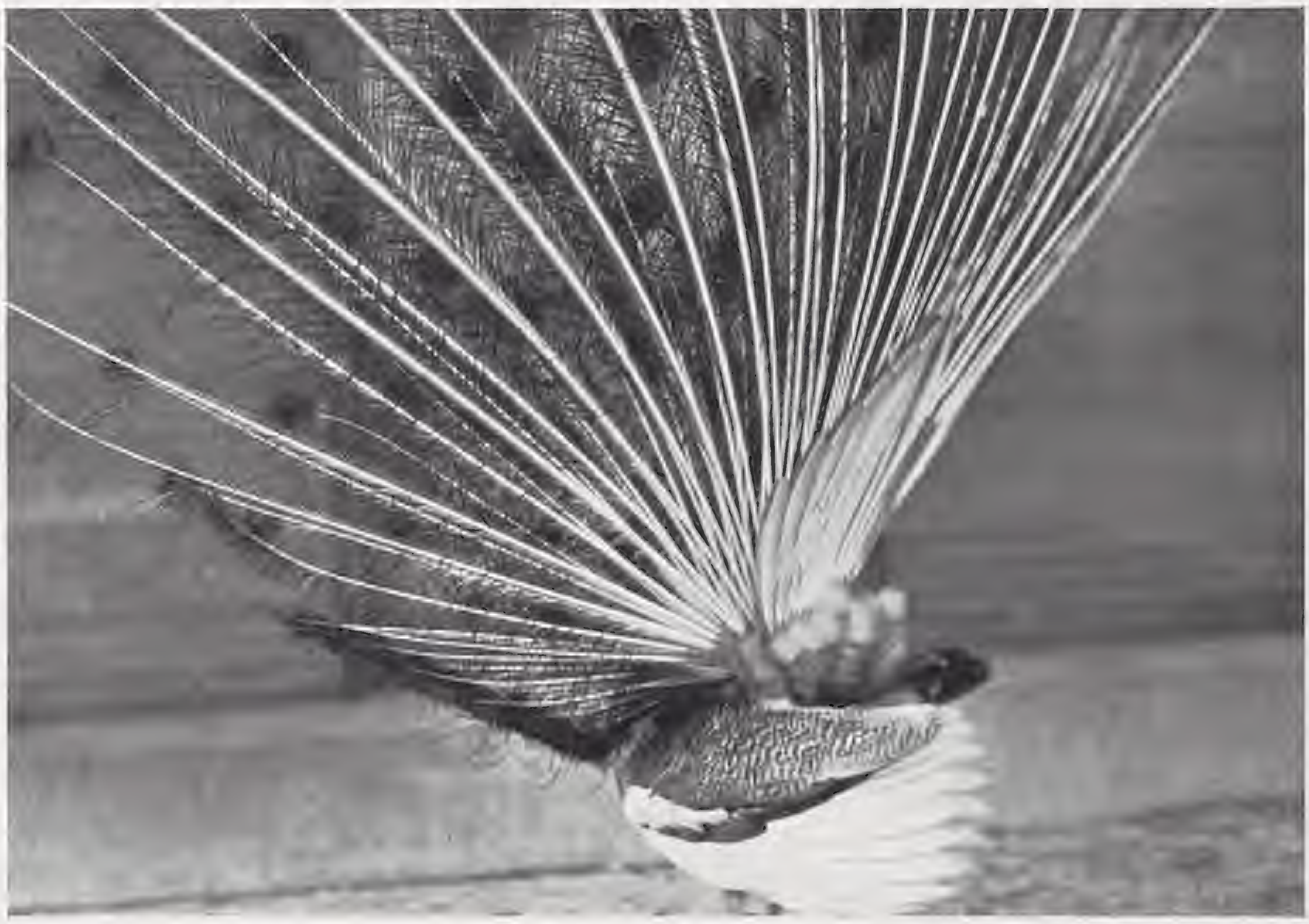


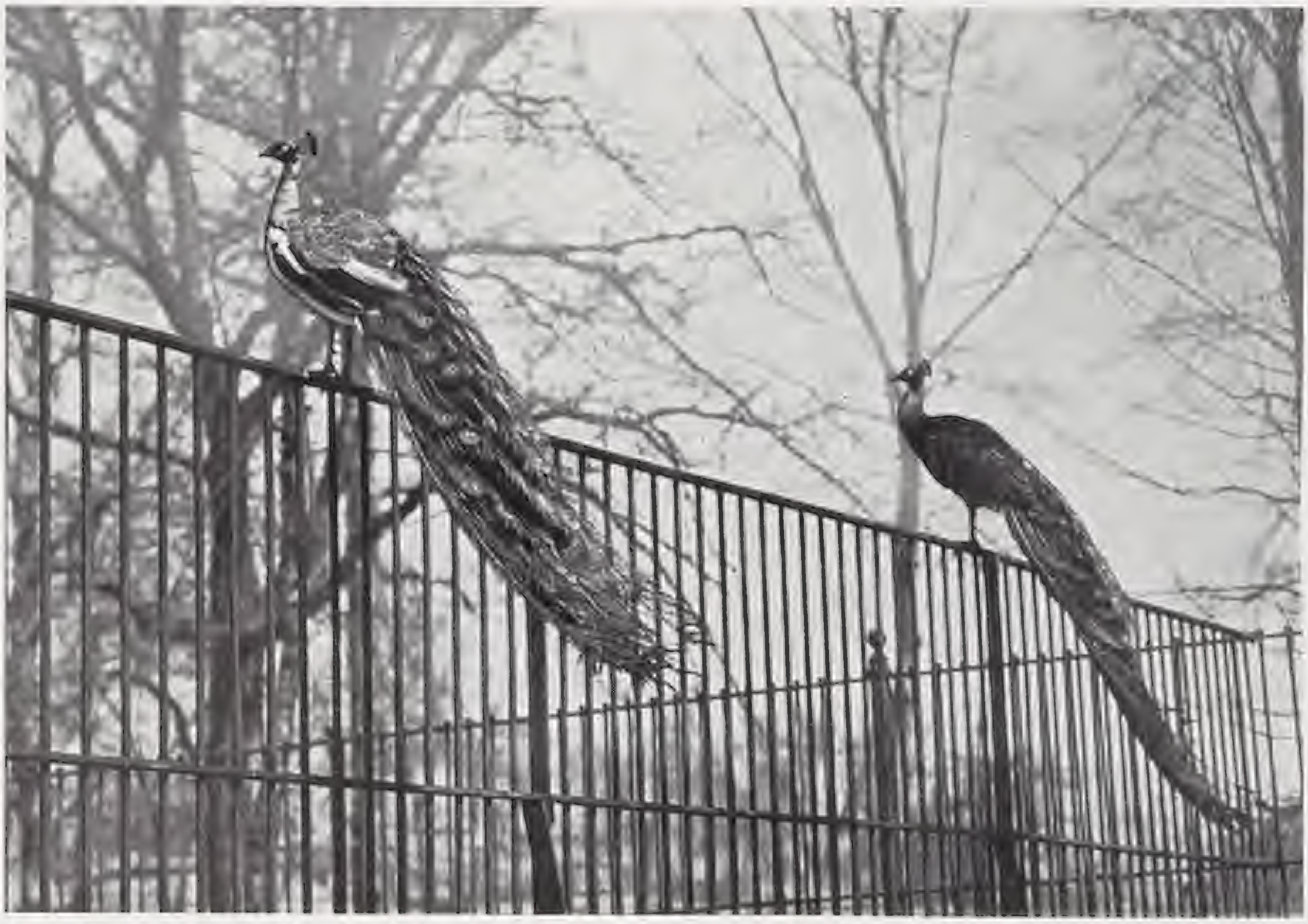
White peacock in full display. This bird possesses an ethereal beauty that compensates for the lack of pigment. The train of the peacock is not acquired until the bird has passed its second birthday and is in its third year. Photograph by Elwin R. Sanborn.



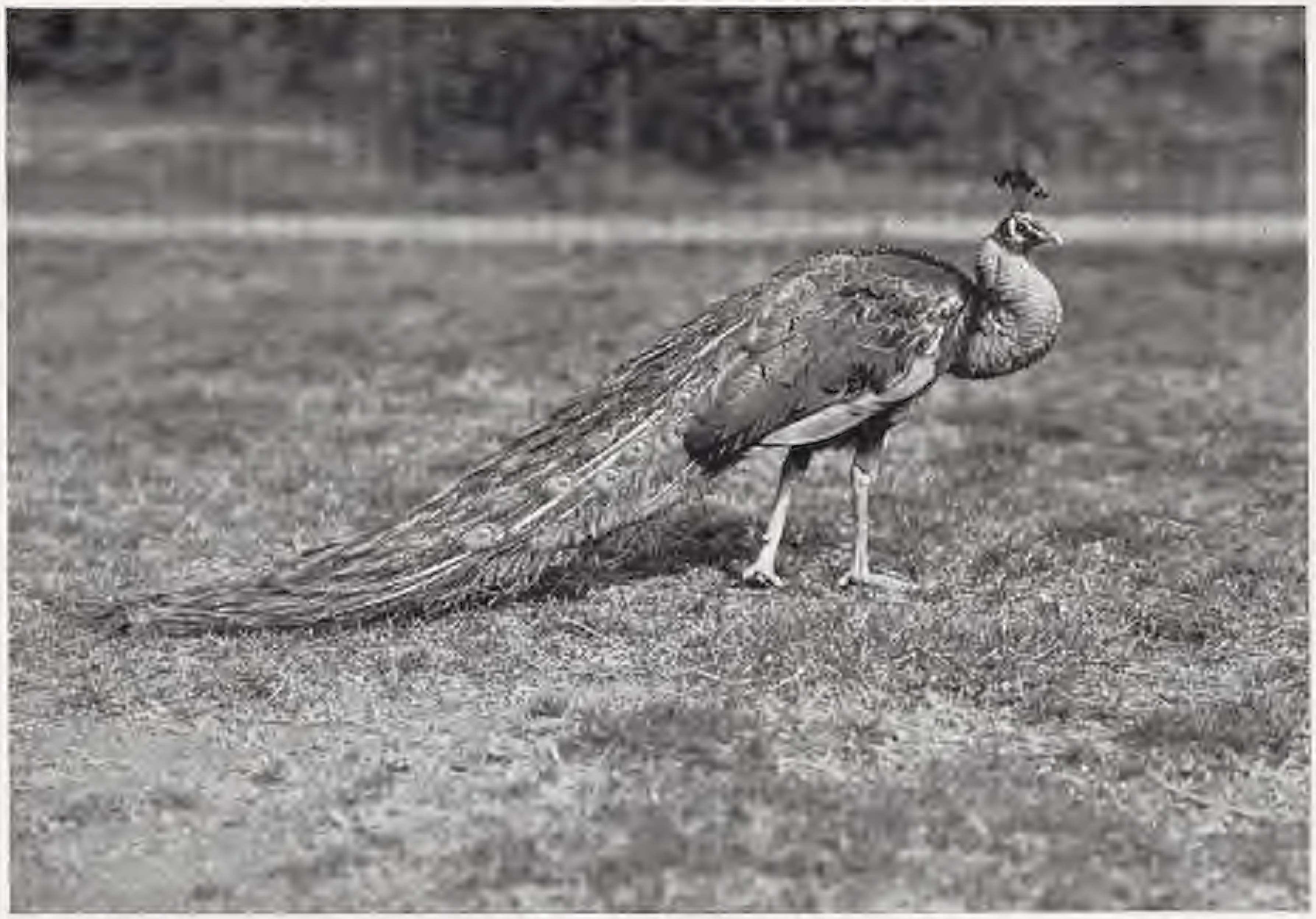


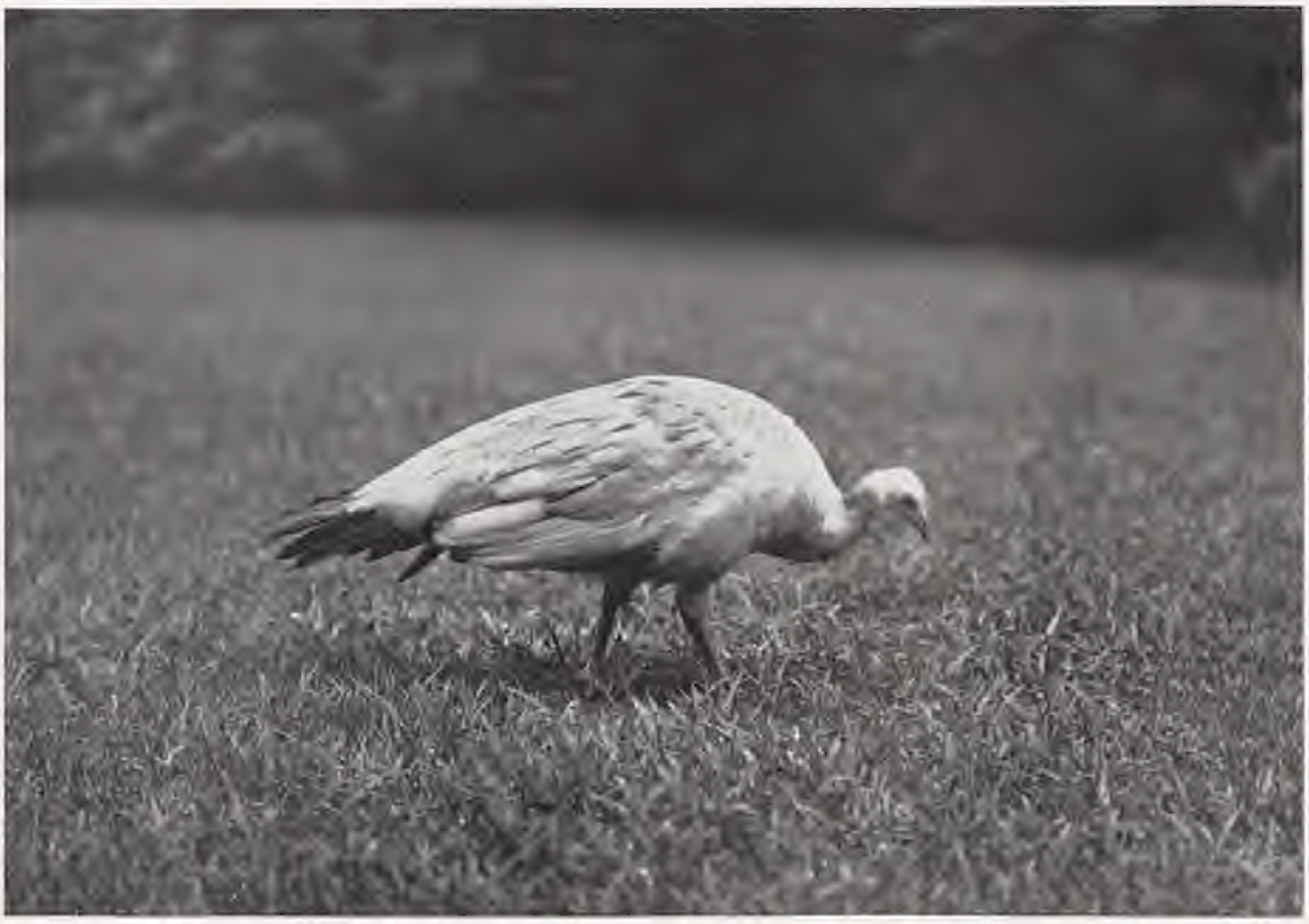
Upper. The molt is a trying period for the peacock. He drops the feathers of his train in June or early July and is seldom entirely fit to be seen before the following February. The bird figured is hardly a creature of beauty, yet he is making a tentative effort to attract attention. *Lower*. Another and more advanced stage of growth. The train is full and symmetrical in shape but at least another month will pass before the feathers reach their final length. Photographs by Elwin R. Sanborn.



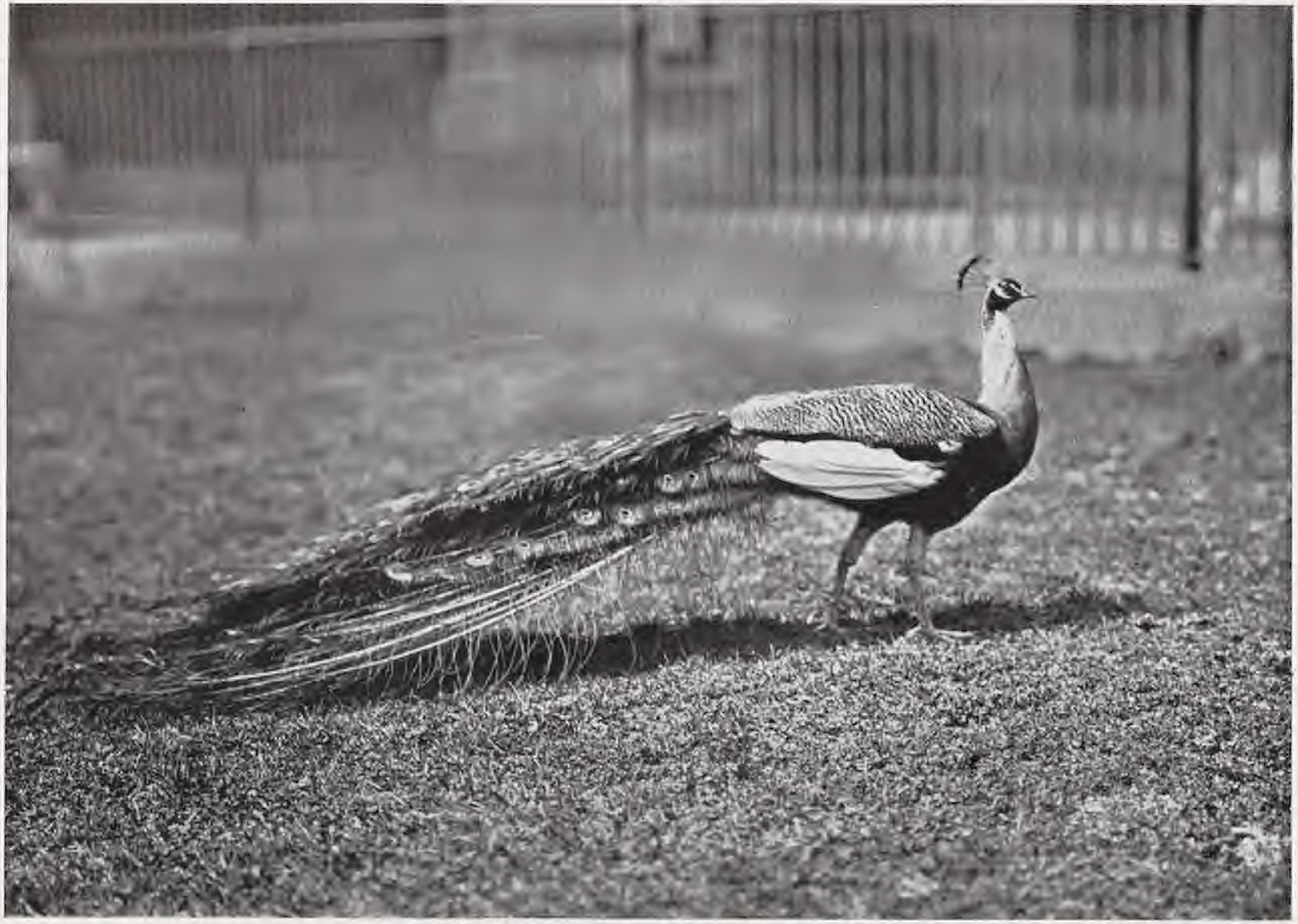


Upper. The feathers of the train are not the true tail but simply elongated upper tail coverts. The tail itself is dull brown in color and functions as a support for the spread train, as seen in this photograph. The bird shown is of the pied variety. *Lower.* Besides the white, there are two other color varieties of the Indian peafowl. In the photograph above, the bird at the left is a pied or splashed, while that at the right is a black-shouldered. Photographs by Elwin R. Sanborn.

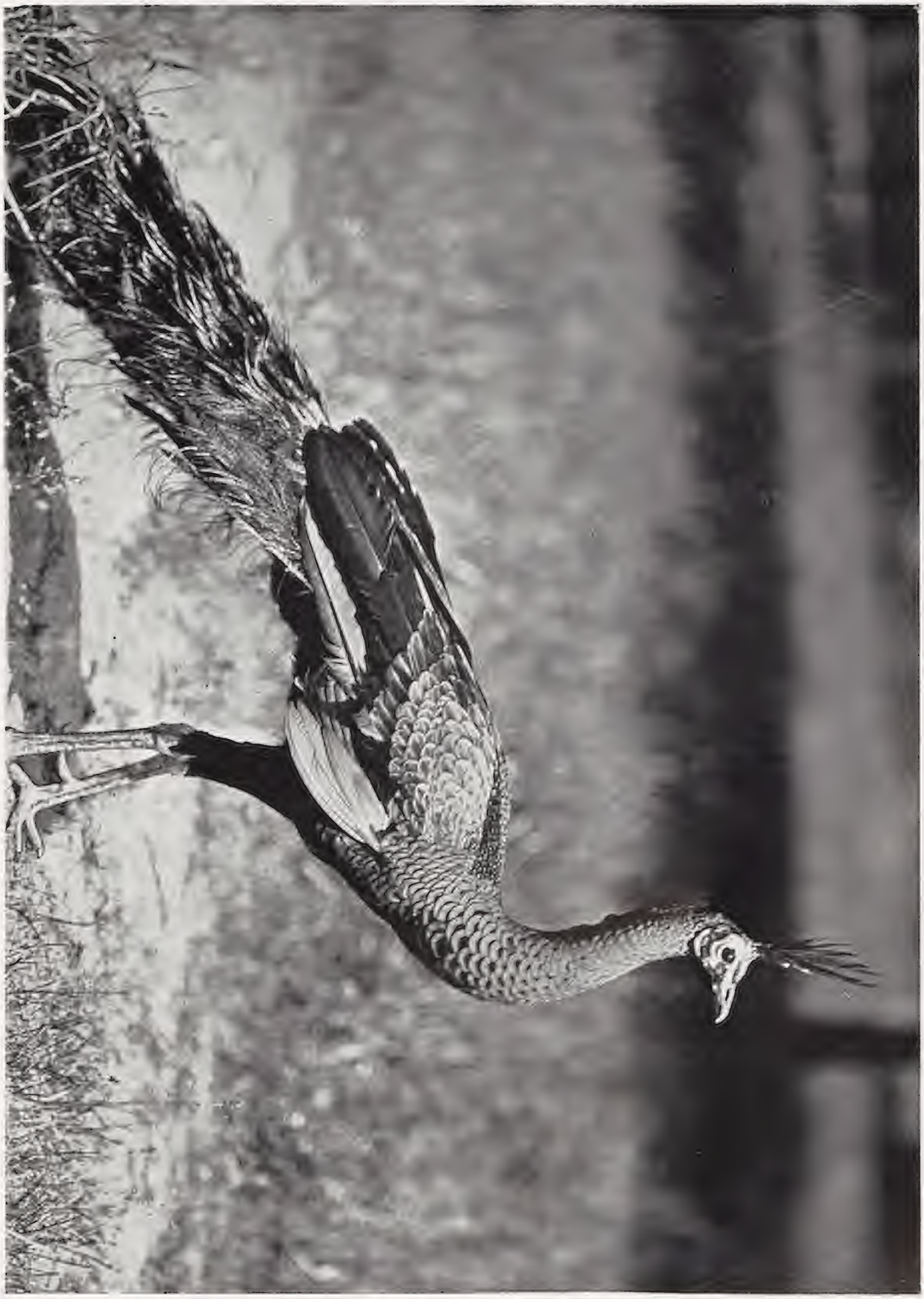




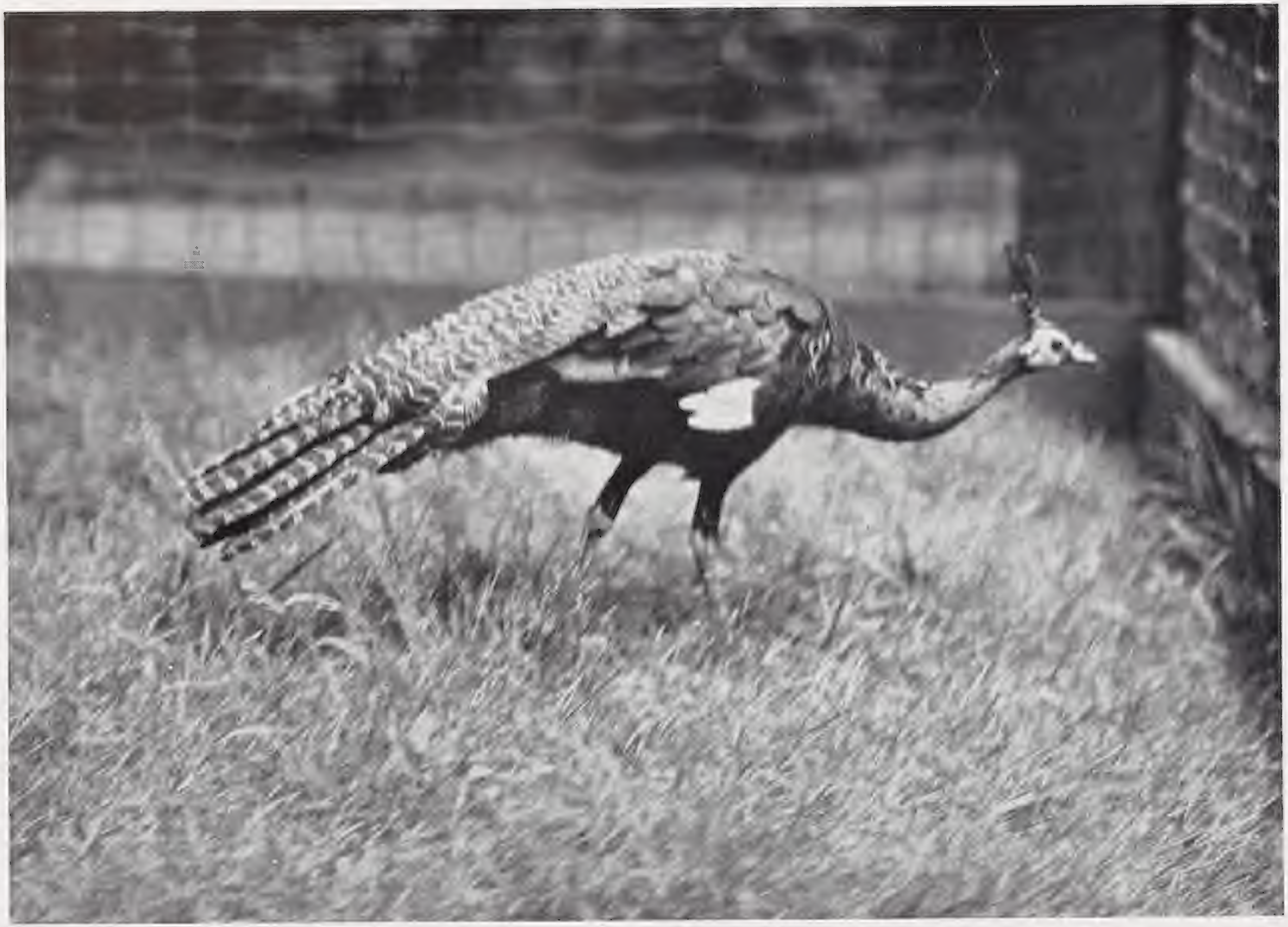
Upper. Black-shouldered peacock. This richly-colored bird is commonly accepted as a mutant from the normal Indian. It differs chiefly in having the black-and-white-barred wing coverts replaced by highly iridescent black. The general color, also, appears to be of a deeper tone. Photograph by Elwin R. Sanborn. *Lower.* Black-shouldered peahen. Strangely enough, the consort of the black-shouldered cock is very nearly white, with pale green neck, a tinge of rufus on the nape and black edgings on wing and tail feathers. The chicks are white when hatched, the young cocks becoming darker at each molt. Photograph by Edward R. Osterndorff.



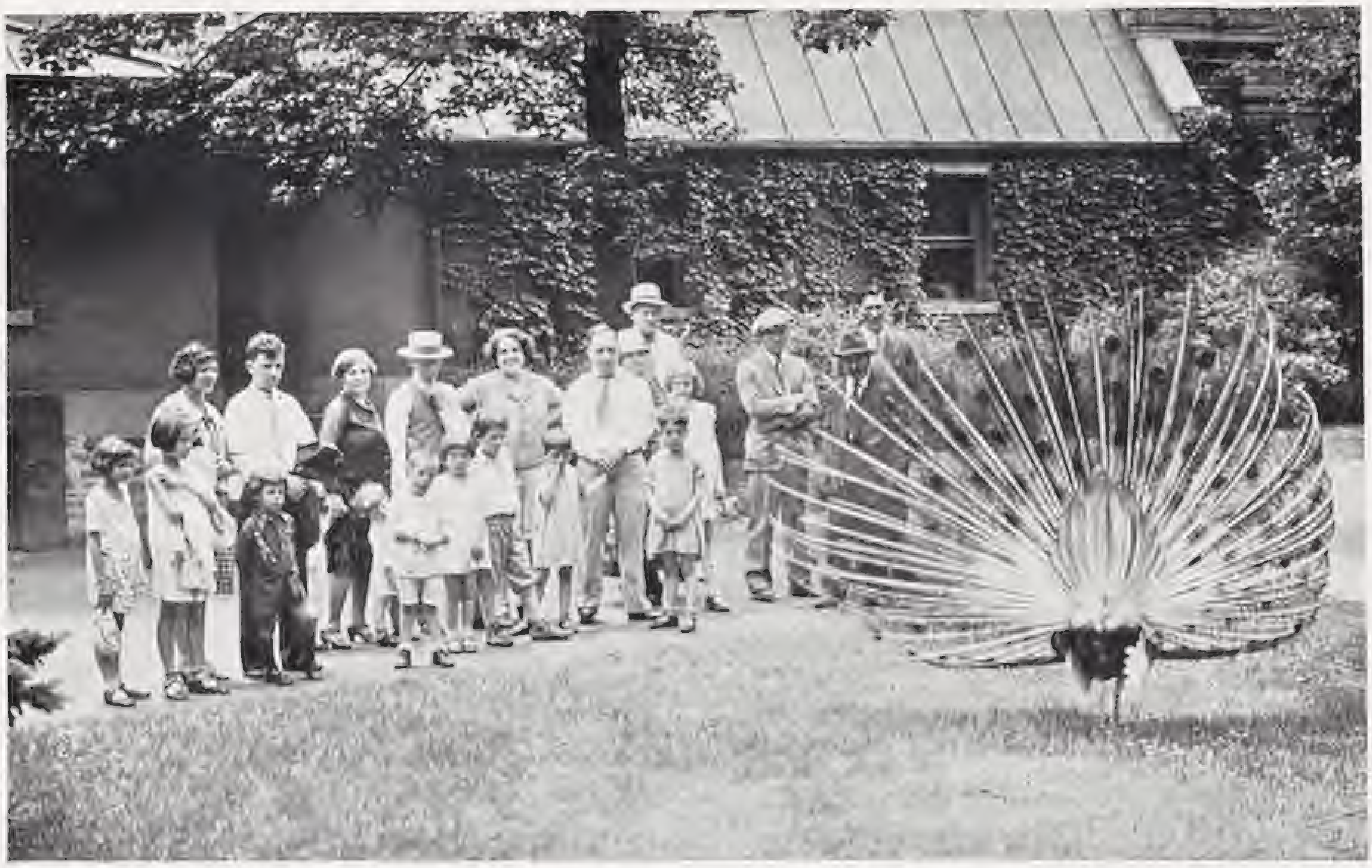
Pied peacock. This variety of the Indian appears to have been originated by an infusion of white blood. Most specimens show white in the wings, with further markings about the head and neck.
Photograph by Elwin R. Sanborn.

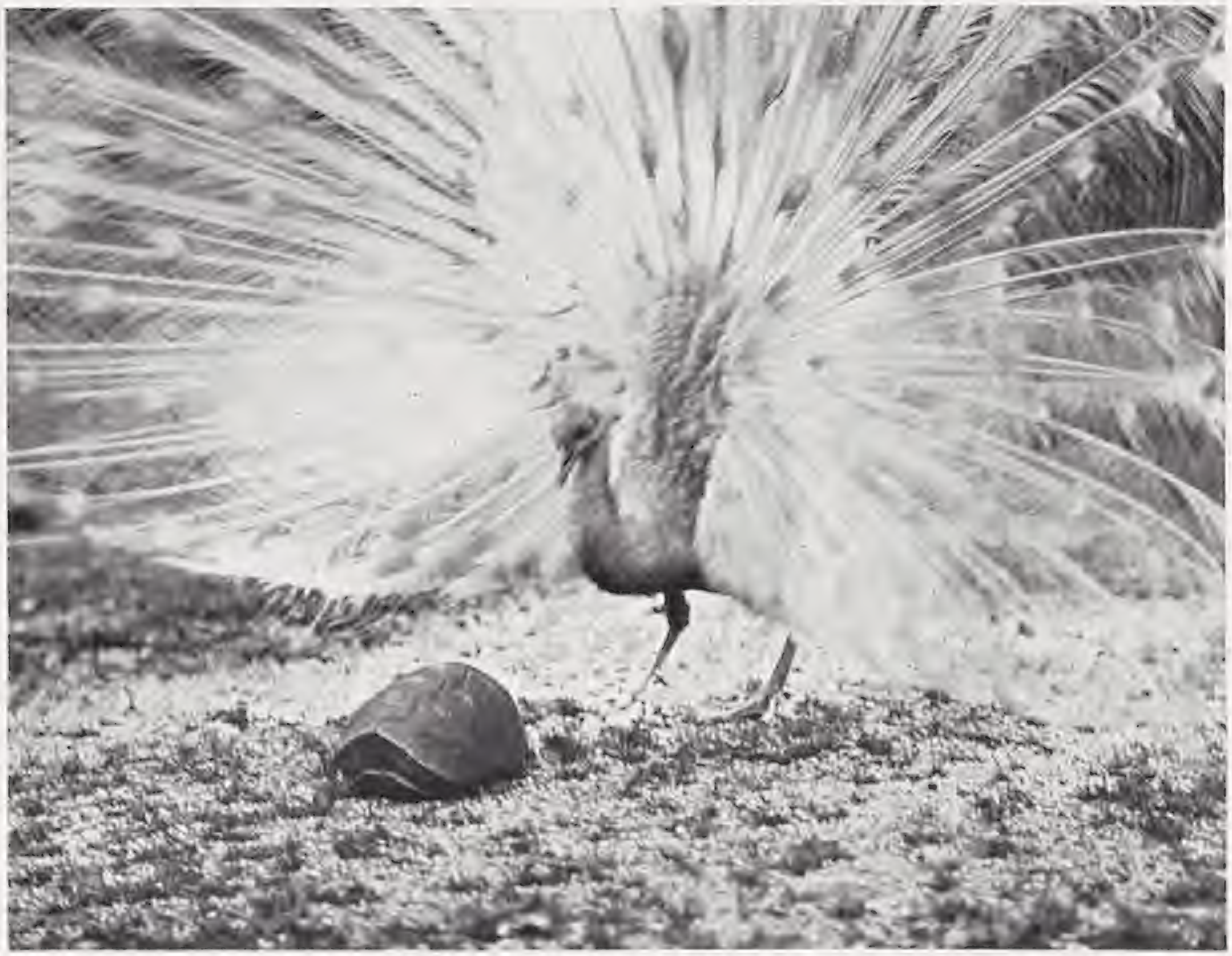


Male of the Javan peafowl (*Pavo muticus*). This bird differs in several particulars from its western neighbor. The legs are long and the body slim, so that it stands noticeably higher. The deep blue of the neck and breast are replaced by shimmering green, with a scaled effect. The crest is long and compact, with almost the appearance of a single feather. Photograph by Elwin R. Sanborn.

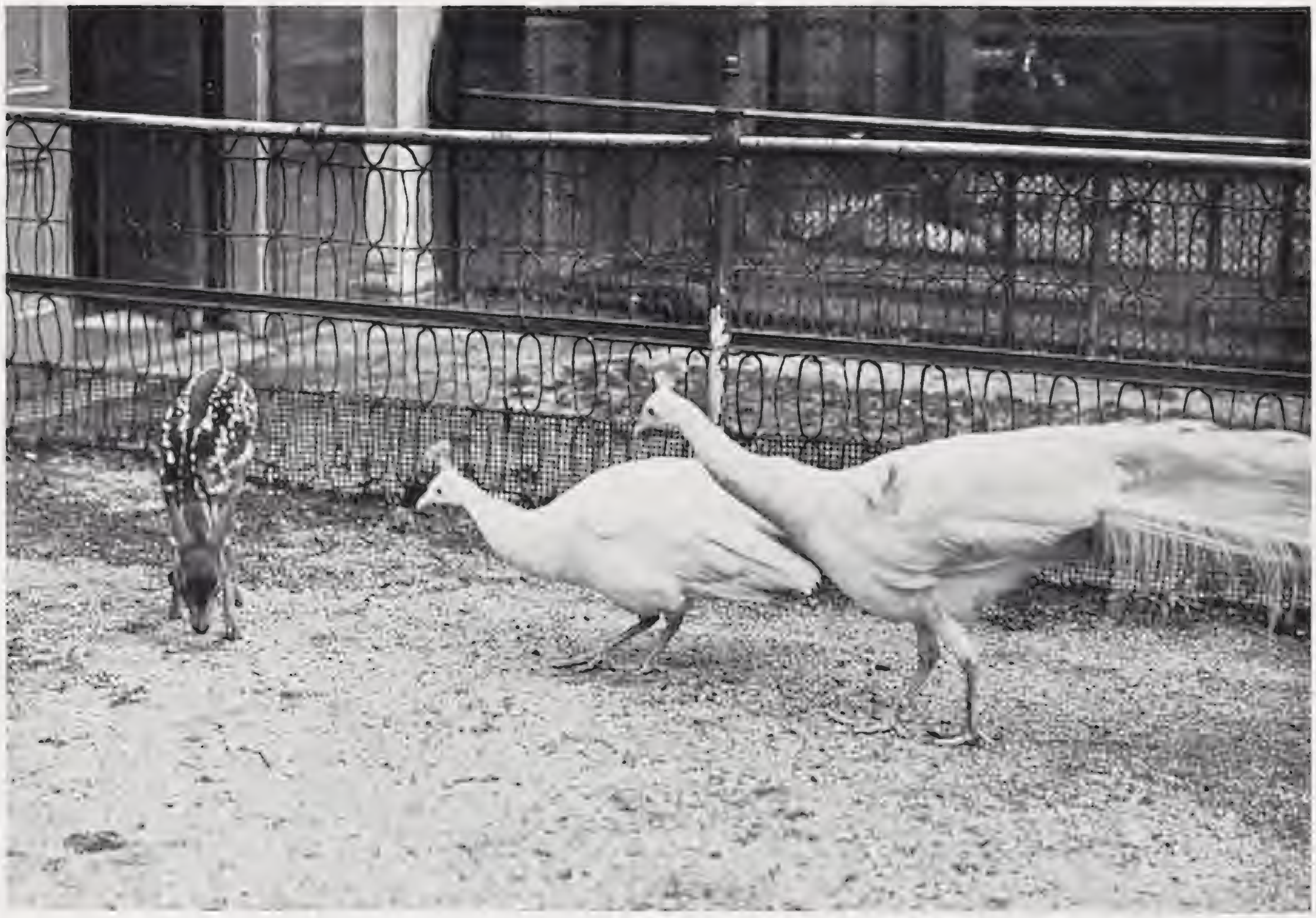


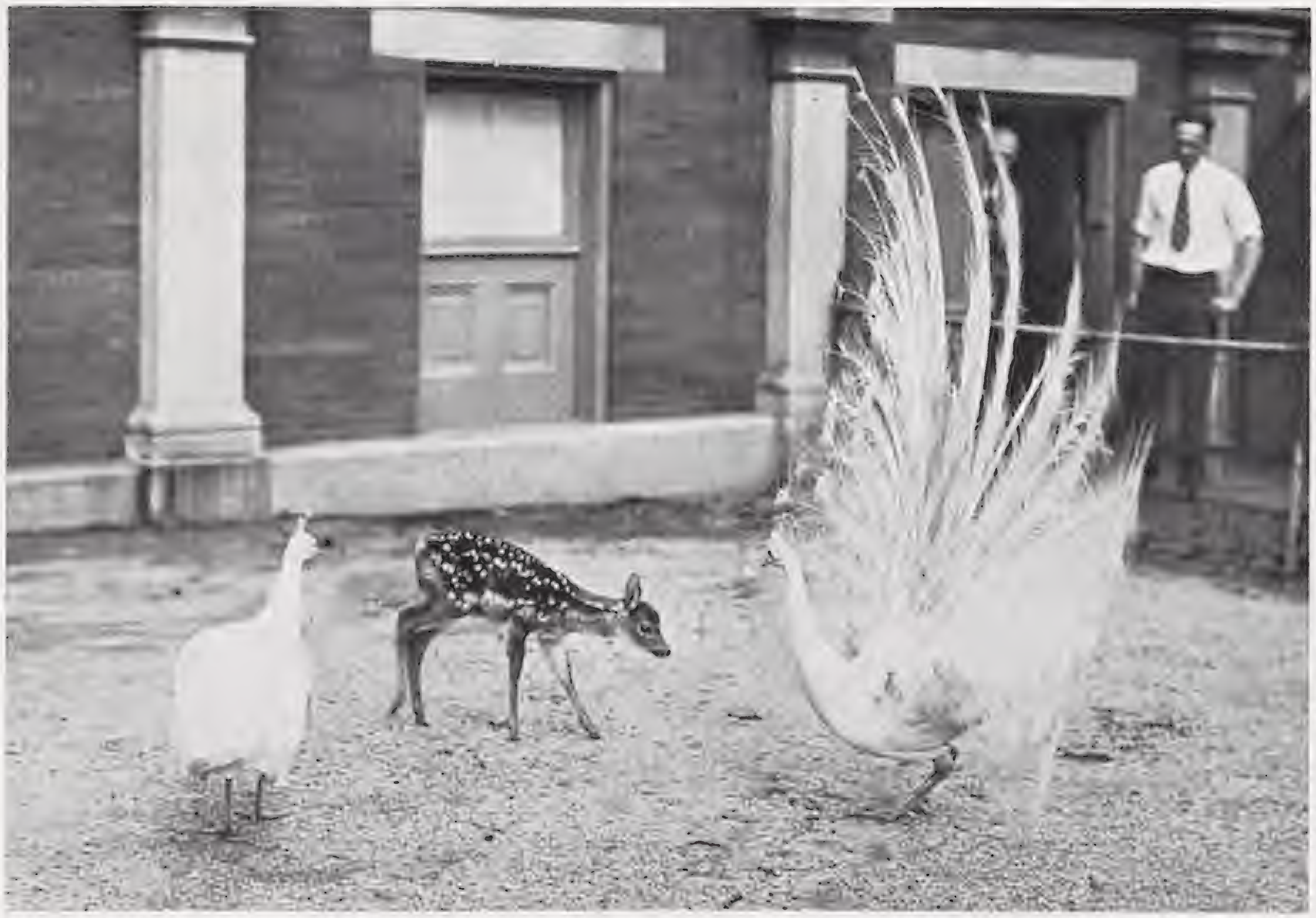
Female of the Javan peafowl (*Pavo muticus*). Unlike the female of the Indian species, the Javan peahen closely resembles her mate, except that she does not possess the train. Often, too, her legs are spurred. Always. however, she may be distinguished by the small patch of brown feathers before the eye, which are replaced by green ones in the male. Photograph by Edward R. Osterndorff.



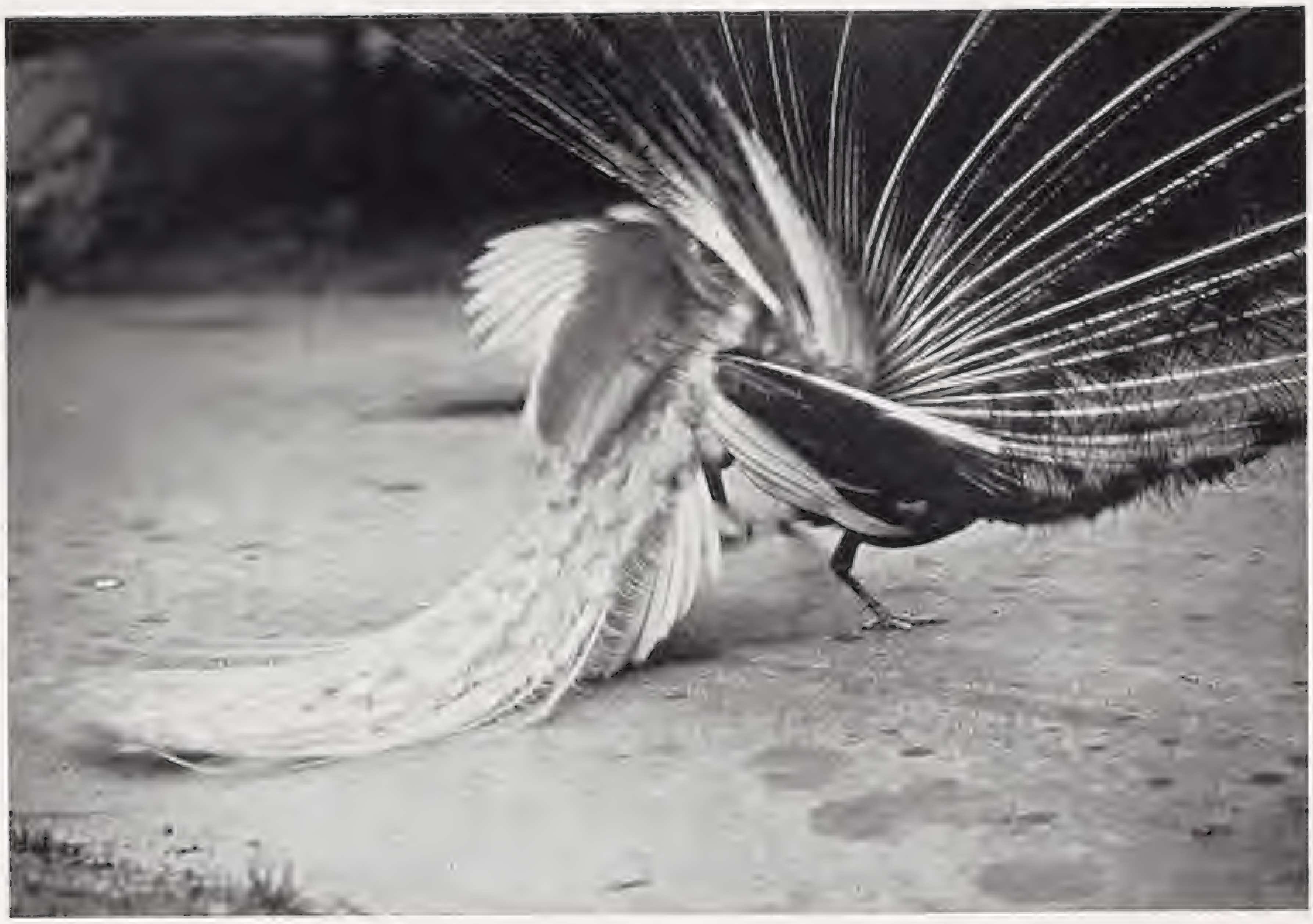


Upper. The peacock has become a symbol of vanity and the conception appears to have a sounder foundation than most popular interpretations of animal behavior. On any fine spring day in the Zoological Park, peacocks may be seen displaying for circles of admiring visitors, whose plaudits appear to rouse the birds to increased efforts. Photograph by Edward R. Osterndorff. *Lower.* The peacock's urge to display sometimes leads him into strange places. The bird pictured was strongly attracted by the tortoises in the runs at the eastern side of the Reptile House and during the spring he spent most of his waking hours there. There was no evidence that his interest was returned. Photograph by Elwin R. Sanborn.

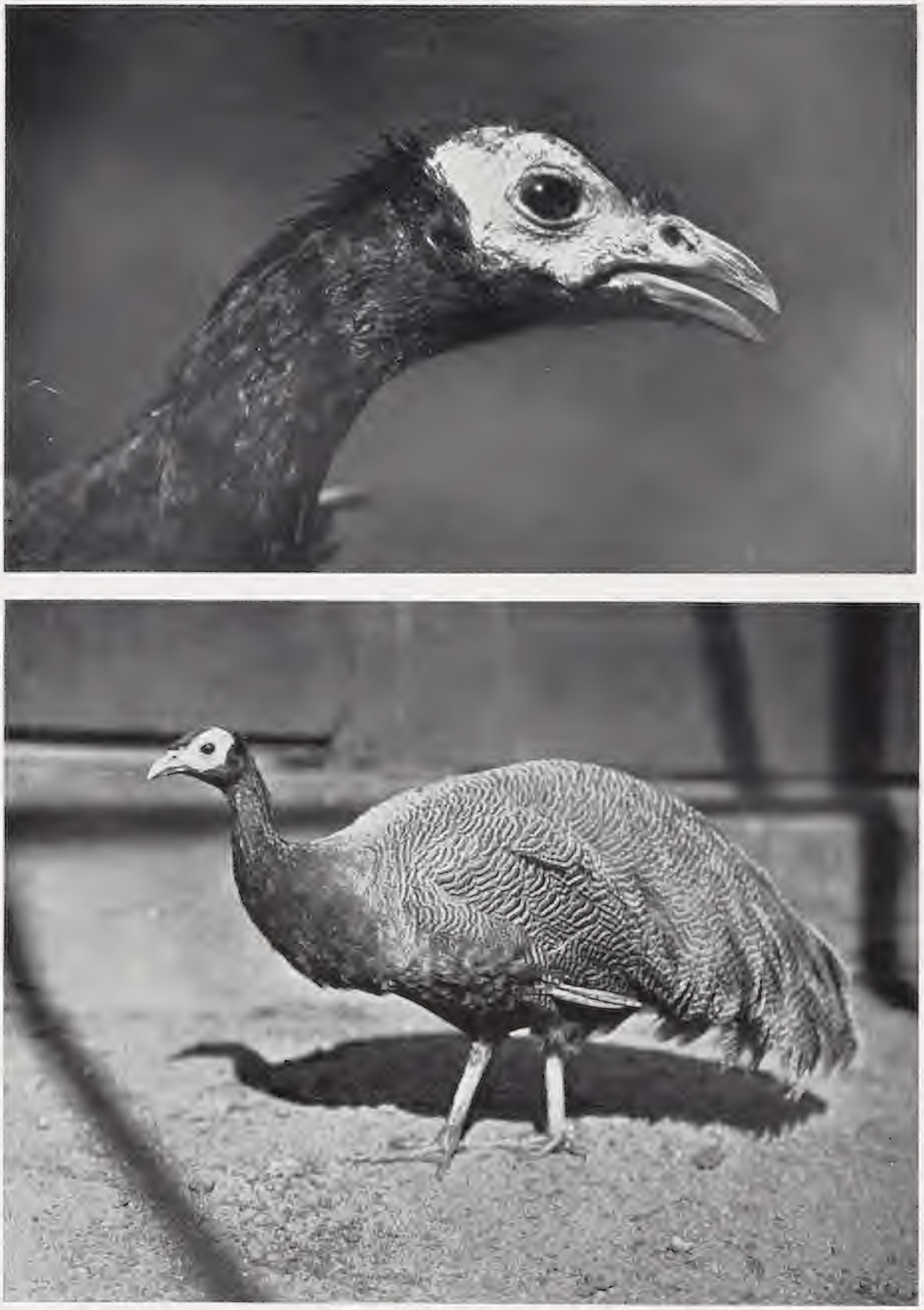




Upper. A young fawn, kept temporarily in the tortoise yards, furnishes a momentary diversion from the tortoises. Even the presence of his lovely mate, whose interest seems even to exceed his own, is not sufficient to deter the white peacock's curiosity. *Lower*. More alert than the lowly tortoises, the fawn does some investigating of his own, to the detriment of a peafowl idyll. Photographs by Edward R. Osterndorff.



Upper. Battles between peacocks are neither frequent nor very fierce. In courtship time, each keeps to his own display ground, which he guards so jealously that it is seldom intruded upon. Occasionally, however, there may be a dispute as to proper ownership but a few quick flurries usually end the argument. *Lower*. Although the Indian peafowl is properly a plains bird and seldom gets higher than the Himalayan foothills, it is almost impervious to cold and snow. The bird pictured was nearly buried in snow during the night but a flight to the ground and a few shakes of his plumage left him with no ill effects.
Photographs by Elwin R. Sanborn.



The Indian and Javan peafowl cross readily, producing handsome, fertile hybrids. Hybrids between peafowl and more distantly related species, however, are rare. The photographs above represent the offspring of an Indian peacock and a domestic guinea-hen, reared in California and until recently living in the Zoological Park. This hybrid is undoubtedly sterile. Photograph by Edward R. Osterndorff.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-six volumes completed. Volume XXXVII in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
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The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
Sea Shore Life (Mayer). *Out of print.*
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend). *Out of print.*
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger). *Out of print.*
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Post-cards: General Exhibits. Sets (12) colored.
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For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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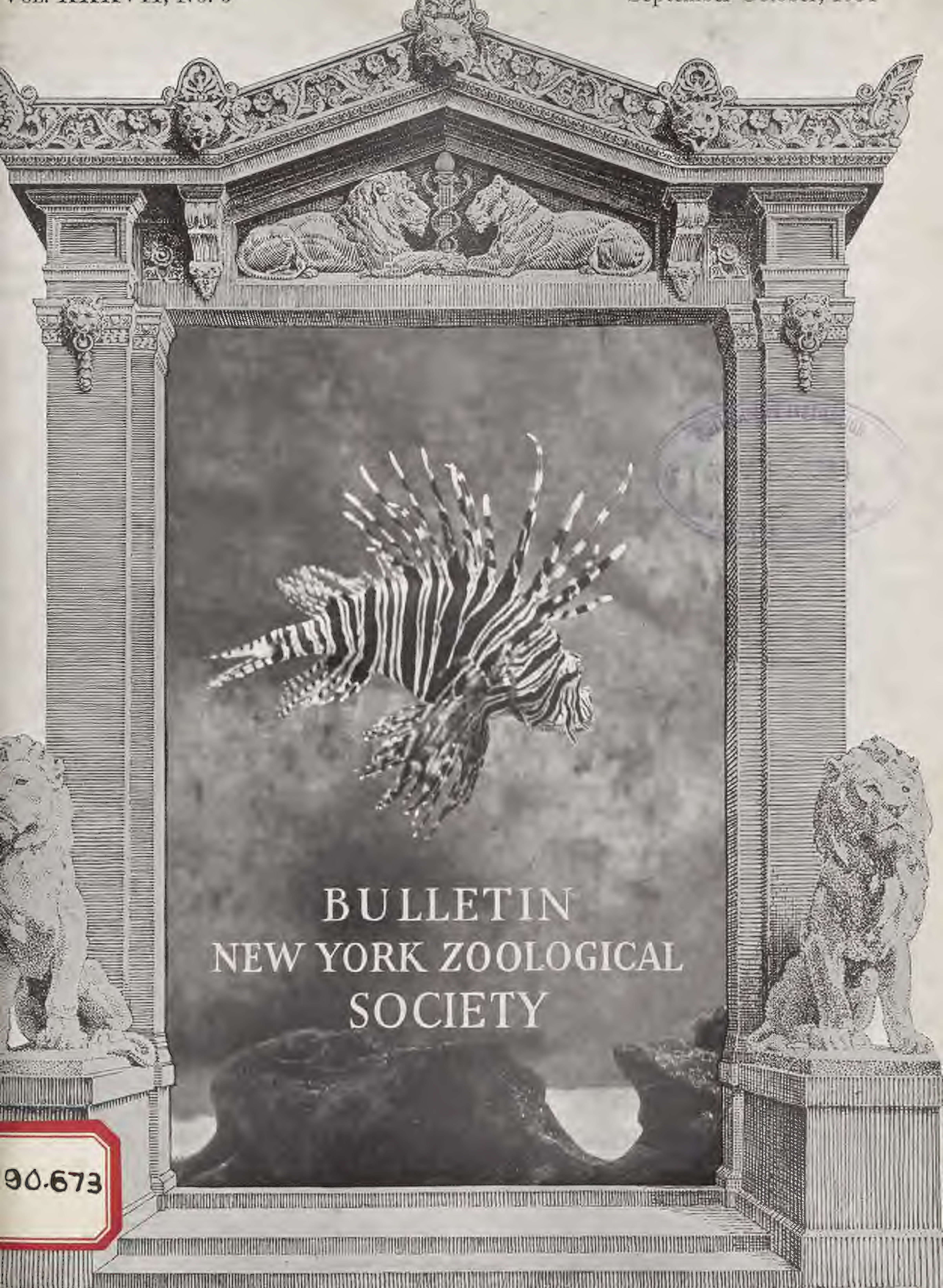

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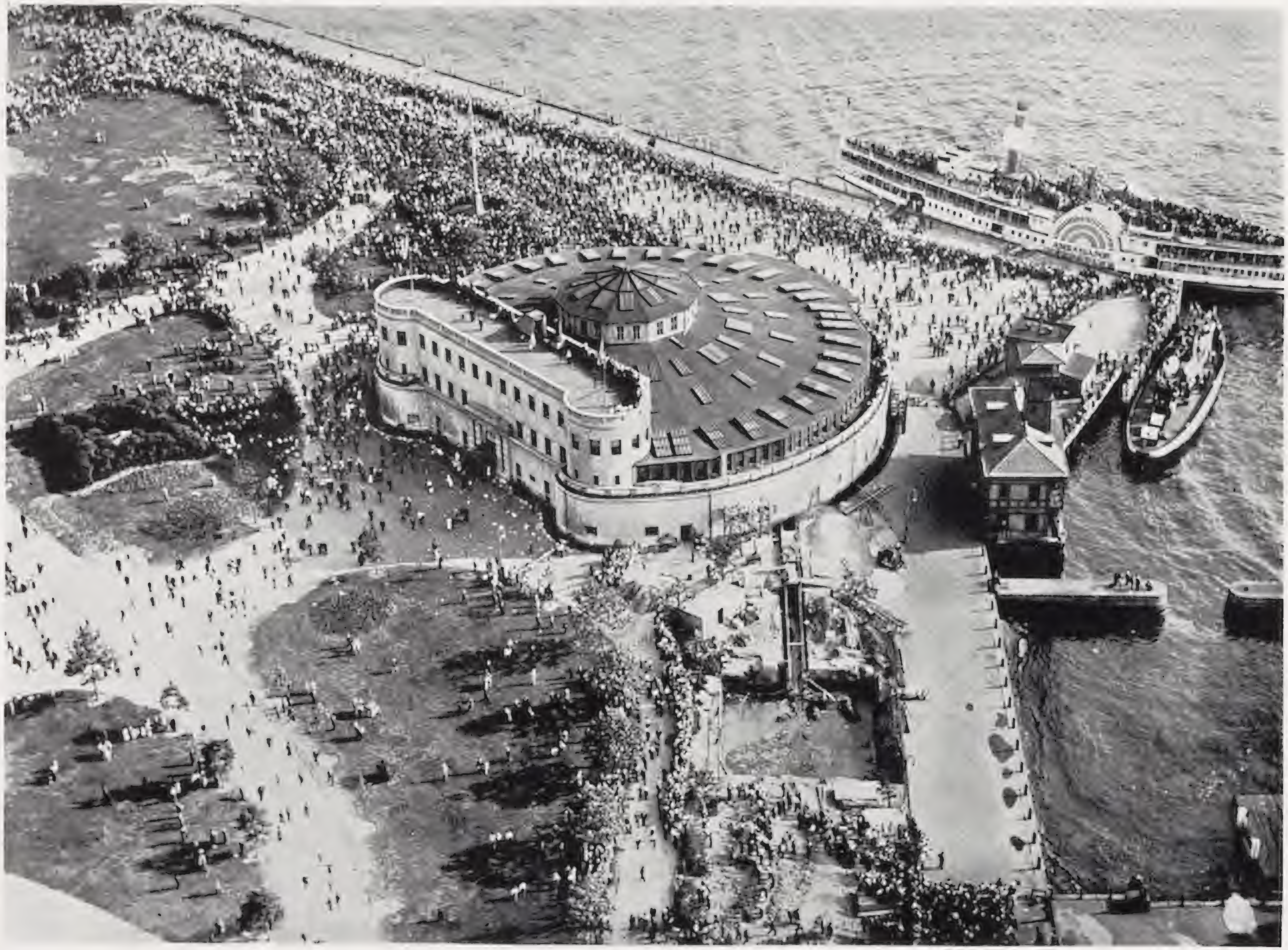

The New York Aquarium at the time of the Navy visit to New York City, May 31, 1934. On this day, 50,640 persons visited the Aquarium. Although such a figure is unusual for a single day, the Aquarium has averaged well over 5,000 a day for years, and between two and two and one-half million visitors per annum. The excavation in the foreground is for the fresh-water reservoir now under construction by the Civil Works Administration. Photograph by courtesy of the *World-Telegram* (New York City) through Mr. Lee B. Wood, Executive Editor.

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The Tide

A brief account of the new tide-recording apparatus at the New York Aquarium.

CHARLES HASKINS TOWNSEND

> *"The water follows the moon, silently with fluid steps*
> *anywhere around the globe."—Walt Whitman.*

THE Aquarium at last has a Tide-Gauge, which shows at all times the exact stages of the sea tides at Battery Park. With an explanatory label the tide-gauge will be interesting and instructive to people who have little acquaintance with the sea; who do not know that the tide rises and falls twice every day, and that navigators must reckon with it accordingly.

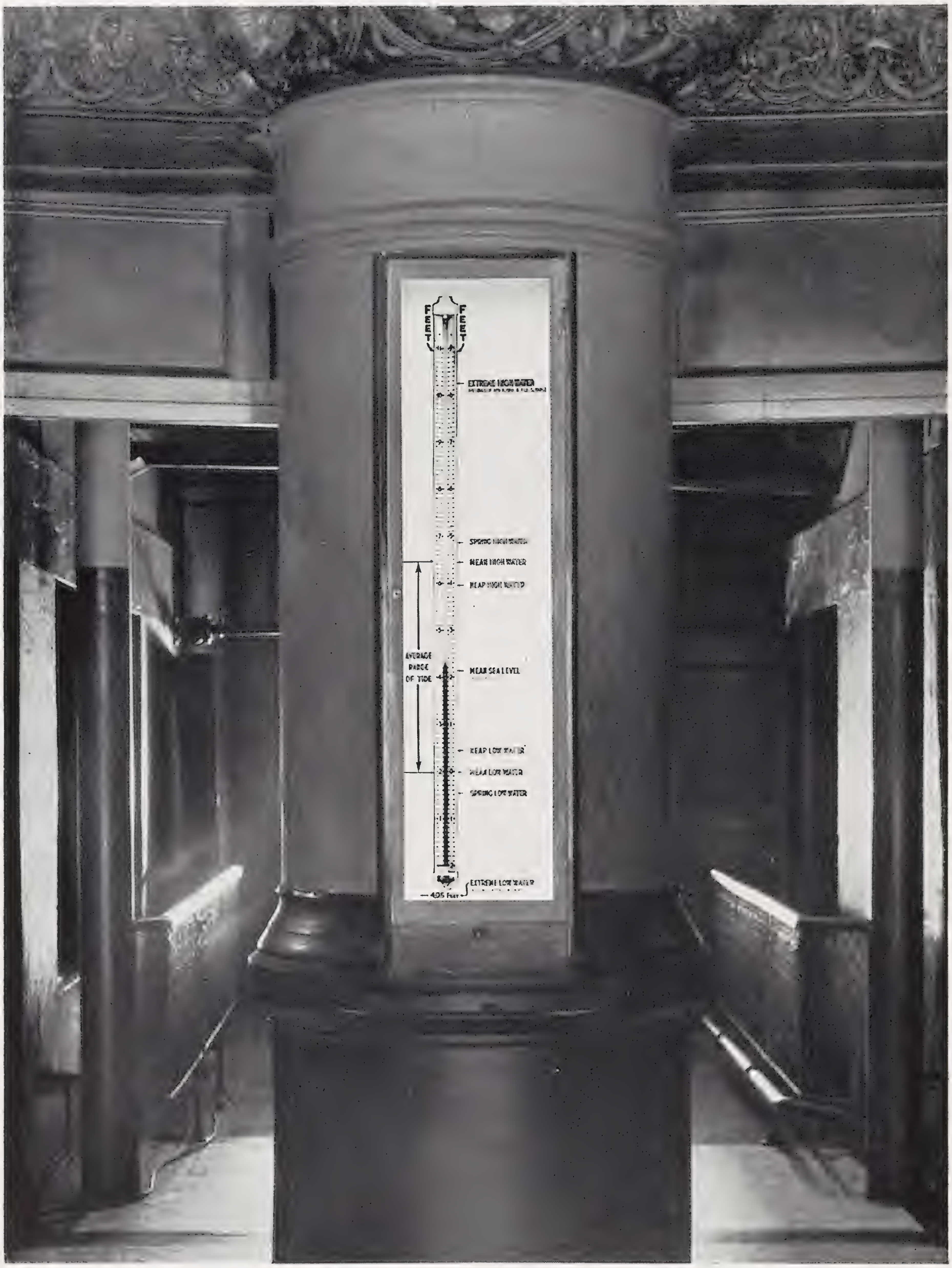
The stage of the tide determines the water-level along the wharves, and its flow and ebb accelerates or retards the movements of vessels entering or leaving port. Its action is perpetual because the moon in its monthly course pulls the tide with it around the world from east to west and the earth turns on its axis daily from west to east. The sun also pulls the tide but its influence is less than half that of the moon because of its immensely greater distance from the earth. When both are on one side of the earth and in line with it, the tide is at its highest. It is then called a spring (high) tide. The terms new-moon tide and full-moon tide are also applicable. When sun and moon are not in line with the earth they pull at cross purposes with the result that the behavior of the tide keeps changing until they are again in line with it. At its lowest it is called neap (low) tide, the sun being at right angles with the line of earth and moon. While there are two high and two low tides a day they are nearly an hour later from day to day.

The tide has an effect on many coastwise industries. It fixes the periods during which clam diggers and oyster tongers may operate; fishermen in different localities along shore keep informed on its movements to get the best results with nets and lines, because fishes move inshore as the water rises. Formerly there were mills whose power wheels were turned by rising and falling tides. In rivers such as the Hudson for instance, where the influence of the tide extends above Albany, vessels can move with it advantageously. When the tide is temporarily stationary at high and low water, steamers may dock or leave without difficulty. At other times they may require the help of tugboats.

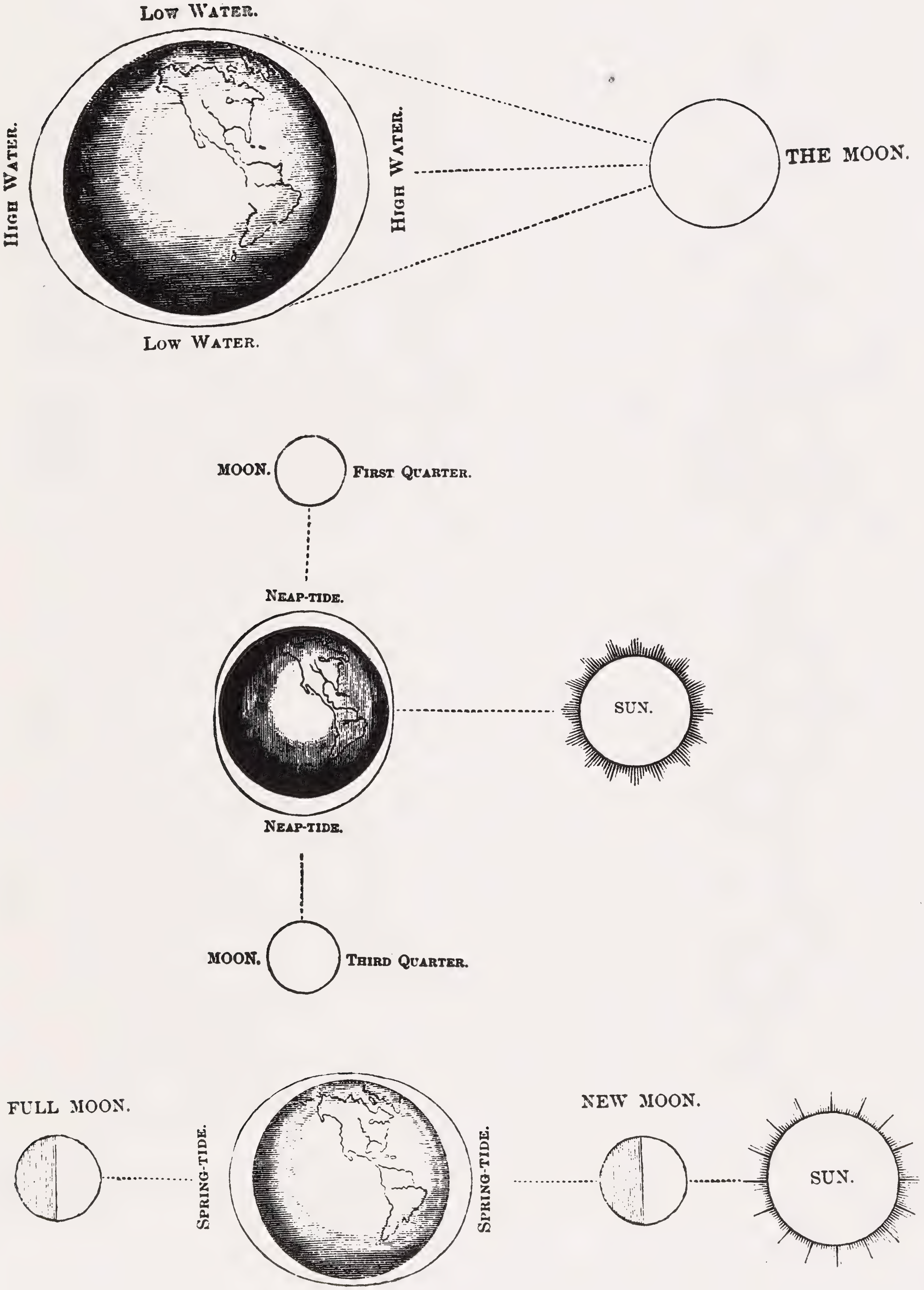
Navigators of all classes keep the run of the tides by consulting the tide-tables published annually by the government. These documents predict the movements of the tides for many localities, by day, hour and in fact, minute, for the whole year. They are obtainable at all ports, so intimately are the lives of maritime folk concerned with the behavior of the tides.

The United States Coast Survey has self recording tide-gauges at many points along the coast which automatically register the movements of the tides at each locality for scientific study. The simple tide-gauge at the Aquarium shows merely the level of the tide at the particular moment of observation.

Were the surface of the earth entirely covered with water there would be no irregularity in the movement of the tide-wave following the moon. But the presence of continents, the irregularity of coast lines and varying depths of



The tide-gauge recently installed in the Aquarium. Besides showing the height of the water, there are various other items marked on the scale, such as mean low water and extreme high water. Photograph by S. C. Dunton.



Diagrams showing positions of sun and moon in relation to stages of tides.
From Johnson's Encyclopedia.

An extreme high tide at the Battery. The water is within a few inches of the sea wall. A slight, further rise would inundate Battery Park. Photograph by S. C. Dunton.

water along shore produce complications. The tide is never the same in any two places. While its ordinary rise and fall at the Battery is only about four feet, its range is nearly twice that at the head of Long Island Sound and nine feet at Boston. There are places where owing to the configuration of the land, the tide rises to enormous heights, as in the Bay of Fundy. At the Atlantic end of the Panama Canal the tide has a rise and fall of only a foot; at the Pacific end its range is from twelve to sixteen feet. There are rivers where the rising tide sweeps in as a dangerous roaring breaker. The flood tide is not confined to the side of the earth next to the moon—there is also high water on the opposite side of the earth at the same time, the moon attracting the earth itself, leaving the water sagging on the other side. Thus the revolution of the earth gives us two tides a day instead of one. Tides are always liable to variations caused by wind and weather.

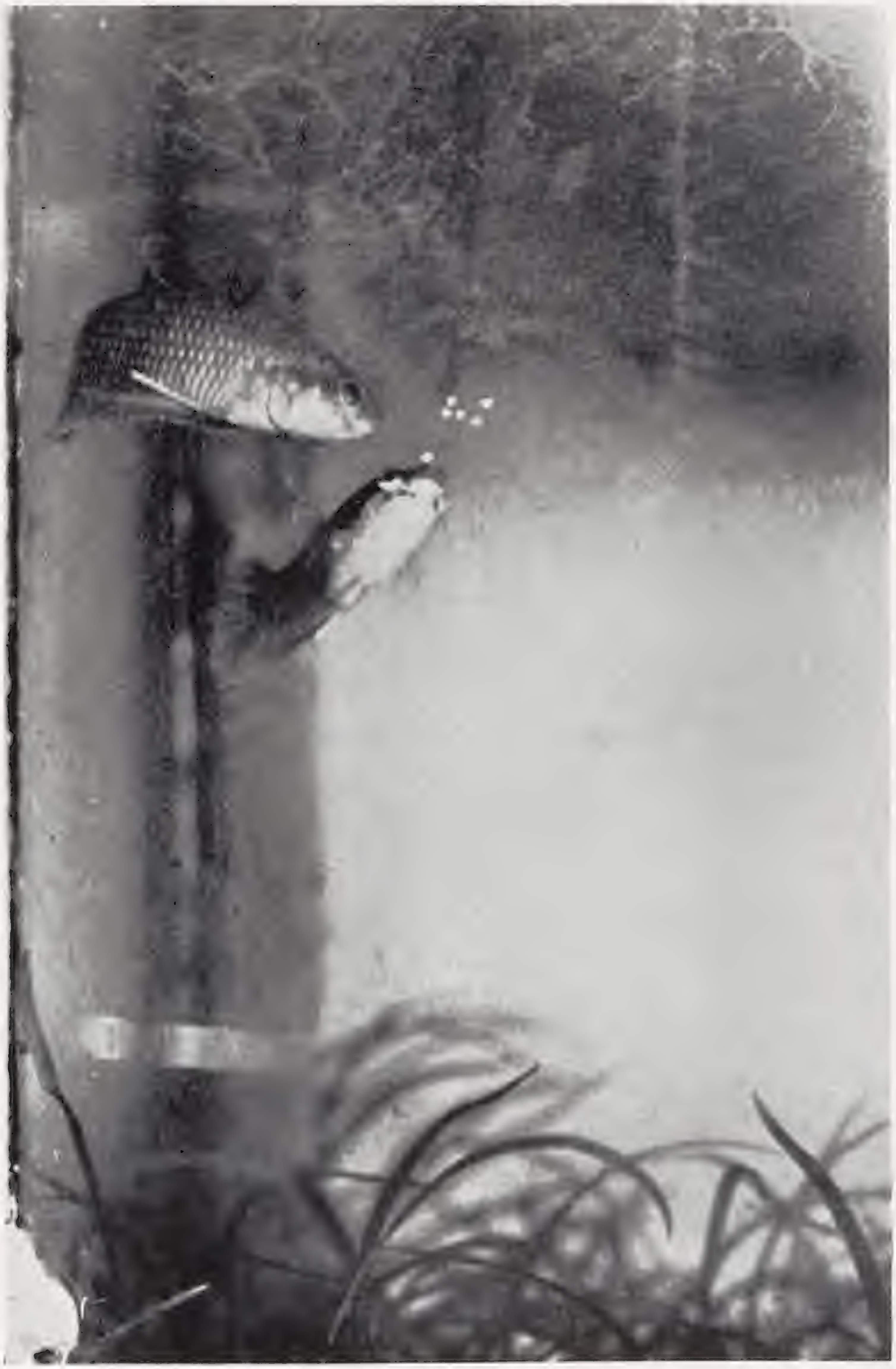
All this is an old story to people who know about the tide. It is told here for the benefit of the really great number of persons who do not know. It is a mere sketch of a vastly complicated matter which considered in detail, would fill and has in fact filled volumes.

The Reproductive Habits of the Painted Betta

A relative of the Siamese fighting fish, new to aquaria.

C. M. Breder, Jr.

In the pursuit of certain studies on the reproductive habits of fishes particular attention was given to forms that showed especially elaborate behavior in regard to courtship, care of young, or other features of procreational activity. One species considered in this connection was the well known Siamese fighting fish, *Betta splendens* Regan. Prior to spawning the male of this species constructs a nest composed of air bubbles which float on the surface of the water. The bubbles are covered with some viscid secretion in the mouth which gives them sufficient



An unnamed species of *Betta* gathering its eggs. The lower fish is the female which has just ejected the eggs from her mouth for the male. Six of them may be seen as white spots immediately above her head. The male, to the left, is about to take them in his mouth where they will remain until the fishes hatching therefrom will be able to care for themselves. Photograph by S. C. Dunton.

permanence for the function which they are to serve. After the nest has been built the male induces a female to come under the construction where spawning takes place. The eggs are heavier than water and consequently sink. The male carefully gathers them up in his mouth and tucks them in the mass of froth constituting the nest. Here he guards and protects them and returns any which may fall out. This care is carried on until after hatching and until the young fish are able to shift for themselves. The above epitomized account is well known and has been discussed at considerable length by various students.

There are two other species congeneric with this one that are sometimes kept in aquaria but are not so well known. One of these *Betta bellica* Sauvage is reported to breed in a manner essentially similar to that of the Siamese fighting fish. Mr. R. W. Lanier of the Steinhart Aquarium, who has had this species under observation assures us that such is the case. The other, *Betta pugnax* (Cantor) is reputed to have the habit of incubating its eggs in the mouth of the male. Since this would appear to be a distinctly different form of reproductive habit, efforts were made to obtain some specimens for study. In this connection the good services of Mr. C. W. Coates of the New York Aquarium were drawn upon. After some effort he succeeded in obtaining two lots of fishes transmitted to him under the name *Betta pugnax*.

The first lot, four fishes, were obtained indirectly from the "Aquarium Hamburg" a commercial house. They were supposed to come from Johore. These proved to be oral incubators but they were not *Betta pugnax*. In regard to the identity of these fishes Dr. G. S. Myers of the United States National Museum was consulted, who with his superior acquaintance with labyrinthine fishes is convinced that this first lot of fishes represents an unknown species, while the second lot was not *Betta pugnax* either, but still another species, *Betta picta* (Cuvier and Valenciennes). The exact source of the latter fishes unfortunately is impossible to ascertain at this time, at least. The specimens of *Betta picta,* which we may call the painted betta, were the gift of Dr. K. Kuiper of the Rotterdam Aquarium and were brought to the New York Aquarium through the kind efforts of Mr. J. F. Emde. To both these gentlemen this Institution is grateful once more for their continued efforts in securing rare specimens in its behalf.

The species, as yet unnamed, showed habits that rather clearly indicated the mode of origin of oral incubation in this group. The male fish would select some site, usually a tank corner and perform in it almost exactly as though the site was roofed with a bubble nest. In the pair studied both sexes picked up the eggs and carried them to near the surface of the water and there spat them out and upwards as though discharging them into a nest. The eggs, of course, simply fell to the bottom when they would be retrieved and the performance again gone through. This might go on for half an hour after which time it would be given up. In each case finally the male held all the eggs in its mouth. It seemed that at times the female deliberately transferred the eggs she had to the male. At least she was noted to spit the eggs out only near the head of the male and then to pick them up again only if he failed. It is not difficult to imagine how such a habit could have arisen. The loss of the ability to build a bubble nest or a shift in environment to a place where a fragile froth raft could not be successful would readily account for the observed behavior. The failure to find a suitable depository for the eggs could then culminate in the simple retention of them in the mouth—oral incubation.[1]

An assumption that the evolution of these habits moved the other way could hardly be argued, for the group of fishes to which the *Bettas* belong are marked by their building of froth nests. This is common to many of them, whereas oral incubation, within this group, with possibly two exceptions (*Luciocephalus* and *Sphaerichthys*) is confined to the genus under discussion.

The reproductive habits of the painted betta are rather similar to those described above but they are not as clearly marked. The male simply

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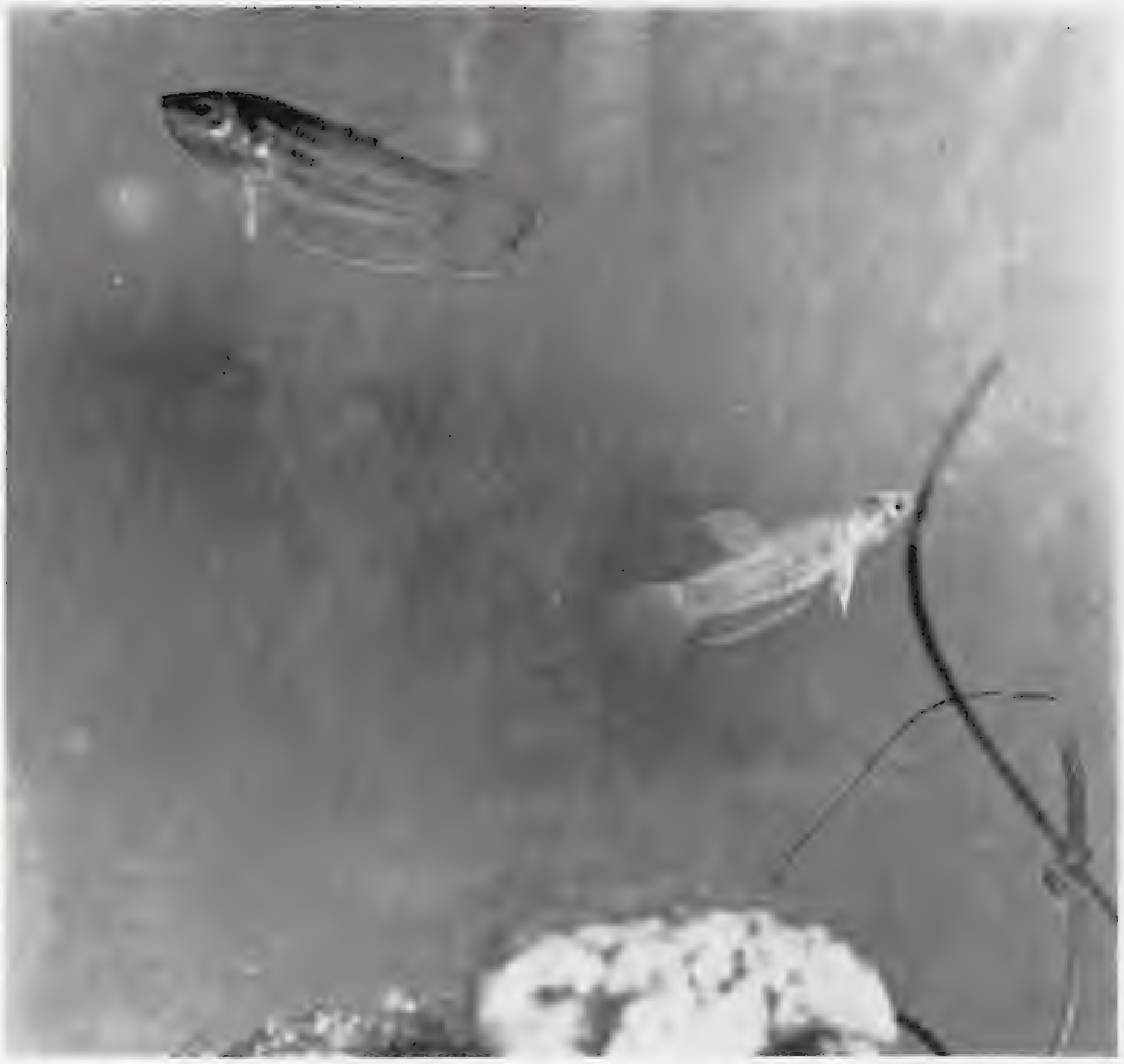
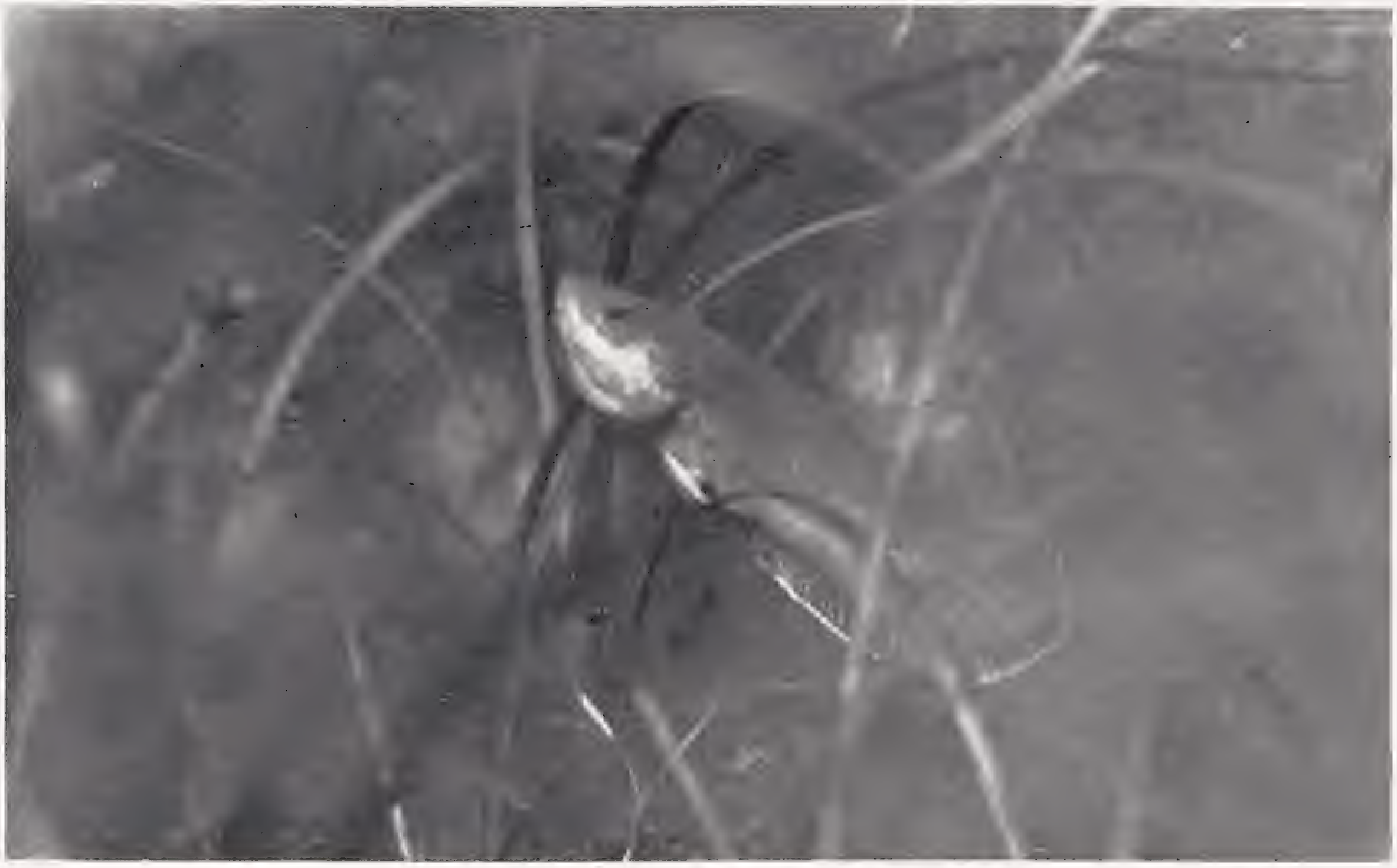
[1] Since this was written an article by W. L. Brind has appeared in Aquatic Life 18(5):95-98 describing the breeding of this fish under the name *Betta pugnax.* It is in essential agreement with the above, the slight descriptive differences probably being referable to individual differences in the fishes. The specimens were received from the same source and Mr. Brind obtained a detailed description of the habitat from the collector Mr. A. Ramsperger. According to this the species inhabits flowing streams where froth nests could hardly be useful. The Siamese fighting fish on the other hand breeds in rice fields and other still waters.





Upper: The painted betta, *Betta picta*, a new fish for the home aquarium. The male in the upper left. The photographs accompanying this article are apparently the first of this species and we believe the specimens which are in the New York Aquarium to be the only ones in America at least. *Lower:* A male painted betta with a mouthful of incubating eggs. While the eggs are developing the fish spends nearly its entire time resting quietly amid water weeds.

gathered up the eggs and swam off in the actual spawnings observed. The courtship and embrace is similar to that of both the Siamese fighting fish and the undescribed *Betta*. It would consequently seem that *Betta picta* had moved further away from the nest building habit, having "forgotten" even the vestigal ceremonies previously discussed. As with all such fishes the brooding individual takes no food for evident mechanical reasons.

The painted betta is about the size and has the general appearance of the Siamese fighting fish, although the pattern and coloration is somewhat different. Since it has been demonstrated that the Siamese fighting fish will attempt to court objects far more different from it than the painted betta, some experiments were made to determine if these two species, despite their superficially different habits would attempt to cross breed. This was done not with the desire to produce hybrids but more to study the interaction of the reproductive modes. No matings occurred but there was an extensive courtship that seemed, however, only to result in confusion. The most interesting case was observed between a male painted betta and a female fighting fish. Courtship proceeded almost to the point of spawning. Here the female would back off, swim around and eye the brilliant male. The impression could not be avoided that the female was puzzled, if such a word can be applied to a fish, at the stupidity and unwarranted behavior of her suitor.

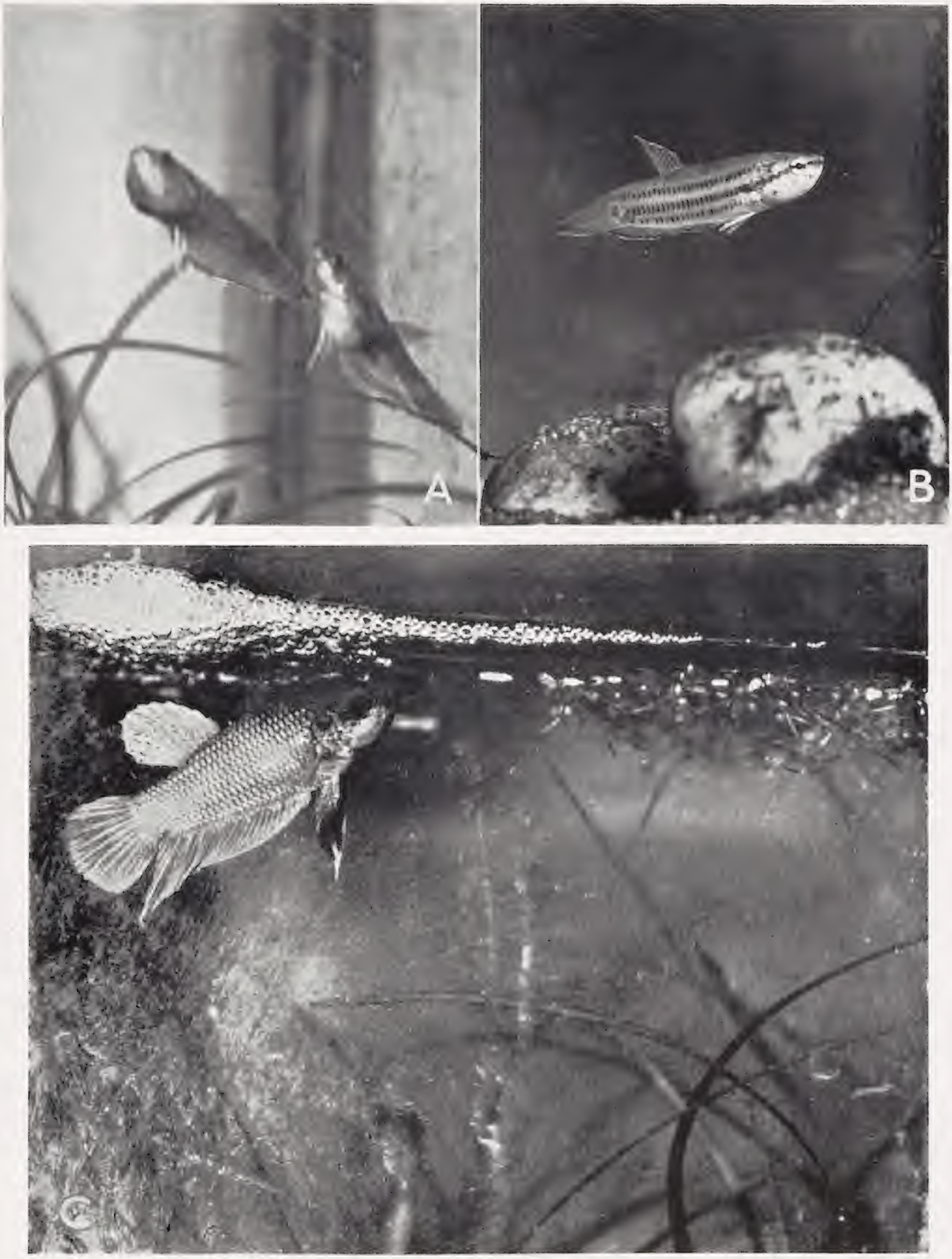
Although there are fourteen species of the genus *Betta*, not including the as yet unnamed one here mentioned, few have found their way into aquaria, but all that have seem to be well adapted for such an environment. No one apparently has ever reported on the habits of *Betta picta* in an aquarium, nor has it been previously mentioned in such connections up to this time, being merely the name of a recognizably distinct species in regional and systematic lists. The *Bettas* thus far kept in aquaria may be listed as follows:

Common Name	Scientific Name	Breeding Habits	Origin
Siamese Fighting Fish	*Betta splendens*	Builds froth nests.	Siam
————	*Betta bellica*	" " "	Perak, etc.
————	*Betta pugnax*	Carries eggs in mouth.	Borneo—a questionable species.
Painted Betta	*Betta picta*	" " " "	Singapore, etc.
————	*Betta sp.* (?)	" " " "	Johore
————	*Betta fusca*	?	Sumatra, etc.

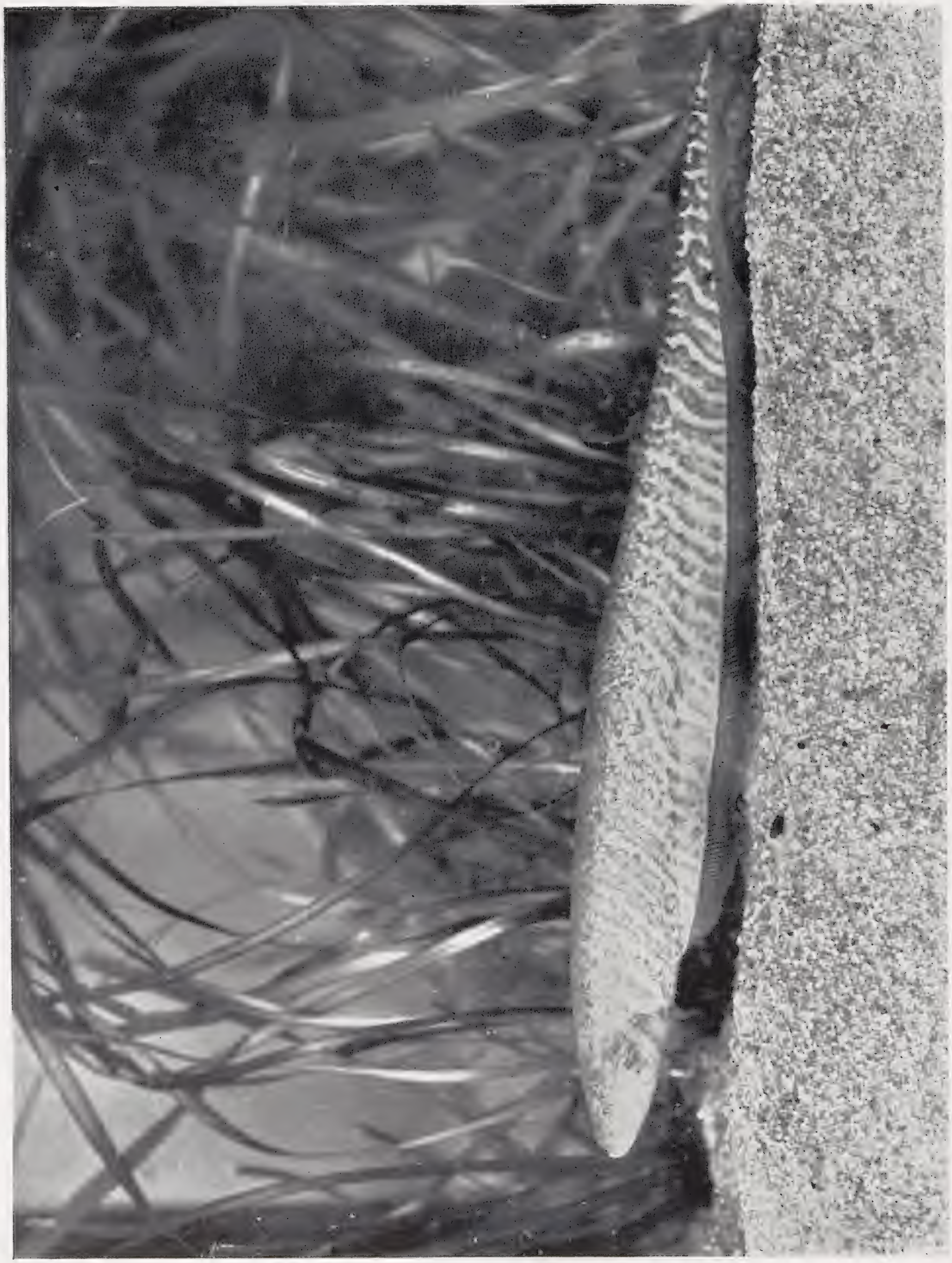
It is thus evident that out of a possible fifteen only six have been kept in aquaria. The last one, *Betta fusca* Regan, included on the authority of Dr. Myers who informs me that he has only seen the name listed in some of the older German aquarium catalogues. Furthermore, the status of *Betta pugnax* is uncertain. Possibly the fish to which this name properly refers has never been kept in aquaria. Since the five of which the habits are known, three carry eggs in their mouths while only two incubate in nests, it is possible that eventually it may be demonstrated that oral incubation is the rule instead of the exception in this genus. This is written on the assumption that the true *Betta pugnax* actually has been kept in aquaria and that it is a valid species.

The best known species, the fighting fish of Siam, appears from time to time under a wide variety of names and fishes obtainable in American aquarium shops show much variation. These are merely varieties of a single species selectively bred for ornamental purposes. It is so well known that it need scarcely be mentioned that the common name is derived from the exceedingly pugnacious nature of the males, which are sometimes used for "sport" after the manner of game cocks.

The painted betta is far less quarrelsome and is an exceedingly timid and nervous little fish, in fact, being so shy that a close study of its habits is not easy. While not as brilliantly colored as the domestic varieties of its quarrelsome cousin it compares favorably with the wild ancestors of that species. Then too there is a very marked change of pattern and color with emotional disturbance. Most prominent and permanent is a broad iridescent blue band along the edge of the long anal fin. This color is on the membrane of the fin and the rays which cross it are a deep maroon. Sometimes rows of bright bluish green dots are present on the sides but more often they are replaced with four broken black stripes on a light background. The tail is most frequently edged with maroon and the dor-



(a) An incubating male painted betta with an unusually large mouthful. The swollen basket-like "jowls" give mute testimony of the apparently uncomfortable proceedings. A female, to the right, has been pursuing the male. It may be noted that this fish is distended with roe that it seems desirous of shedding. (b) A male painted betta showing its striped phase. This coloration is more commonly seen on female fish but occasionally the males also display such a pattern. (c) The bubble nest of the common Siamese fighting fish in the corner of an aquarium. This male, which is close to the wild uncultivated fish is guarding its nest full of eggs. Photographs (B) and (C) by S. C. Dunton.



Gymnotus carapo, a non-electric relative of the electric eel. This fish occurs over most of northern South America and depends upon its well developed teeth for food and defence.

sal with an iridescent green. As in most such fishes the female is comparatively somber, being most frequently a pale tan with horizontal dark stripes. Since the painted betta is easily bred and the young hardy, of a peaceful disposition and rather attractive, it is not unlikely that this species might gain considerable popularity among home aquarists.

Electric eels, *Electrophorus electricus,* from Brazil. The swellings near the heads of these fish indicate full stomachs. These fish are fully conscious of discharges of electricity by each other but are not adversely affected by it.

SOME ELECTRIC FISHES AT THE AQUARIUM

C. W. Coates

Illustrations from photographs by S. C. Dunton

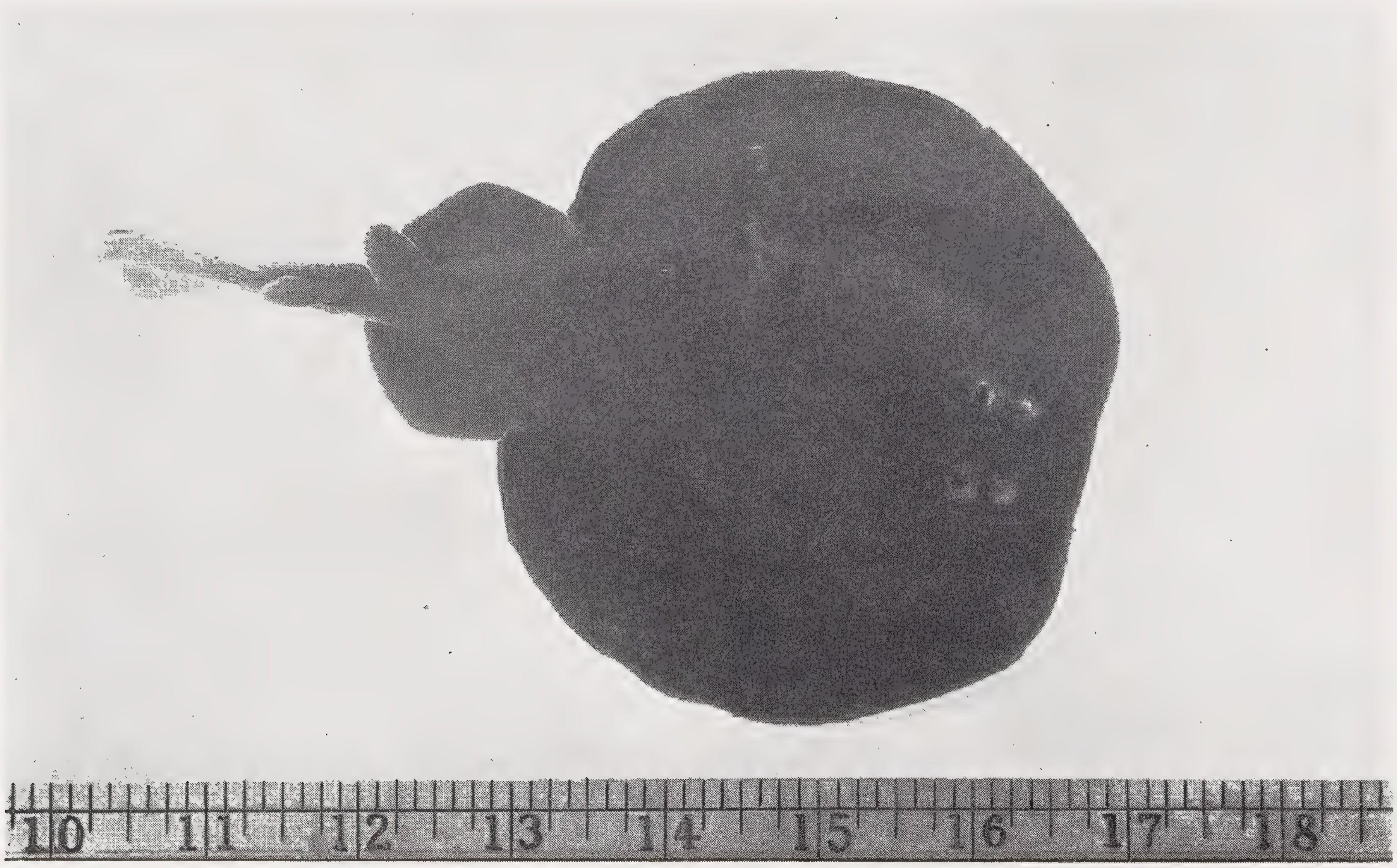
FROM time to time the Aquarium receives and exhibits specimens of the various electric fishes. There are a number of these but, in general, they have not a great value as exhibits, for they are given to hiding in the sand or rockwork in their tanks. If they have neither sand nor holes in which to hide, they usually die. Their electric powers are quite curious and not entirely understood, although all of these fishes have been the subject of much scientific consideration for many years, and we know where they generate and store the electricity.

In the electric eel *Electrophorus electricus,* from northern South America, of which the Aquarium exhibits a specimen about five feet long, the electric organs are known to be three pairs of muscle-like tissue, the chief of which extend from just behind the head almost the whole length of the body on each side of the back-bone. The secondary organs, called Hunter's organs, are smaller and run parallel to these, but closer to the anal fin. The third electric organs are called the Bundles of Sachs and are located along the large electric organs in the latter half of the body.

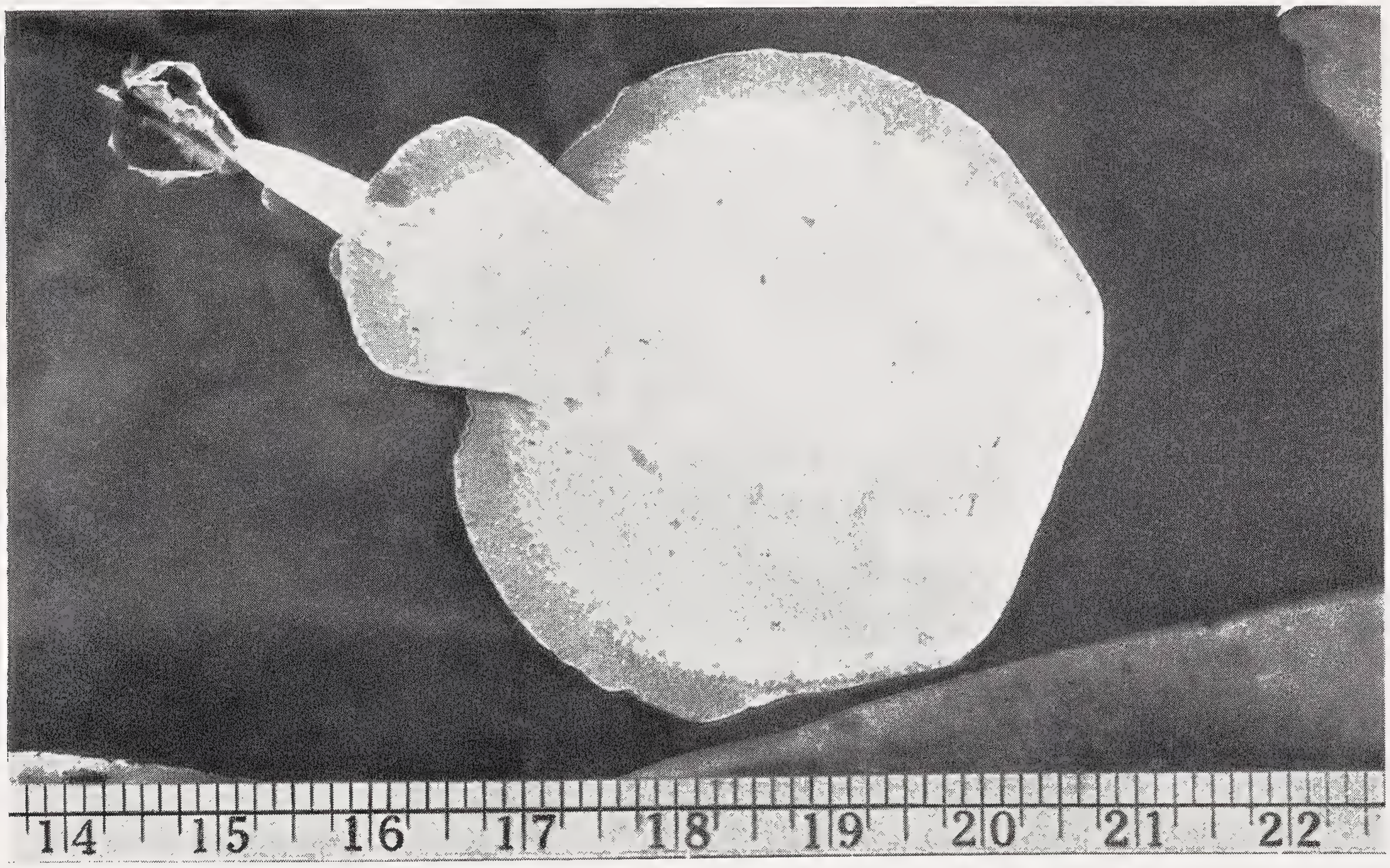
Dr. Carl Sachs made a series of experiments with this fish in its natural environment—on the rios Orinoco and Apuré—in the latter half of the nineteenth century, but unfortunately he died before he had time to make a full report on his observations. He does state, however, that a shock may be received in four different ways—by completing the arc; by conduction; by direct contact, and from the water in which the eel is discharging shocks. Where electricity is produced by ordinary means, it is necessary to make some contact with the ground, if the circuit is not complete, before any shock is felt. In the case of all the electric fishes handled, we have found from our own experiments with these creatures that one may be securely insulated in every way, except one contact with the fish itself, and still feel a very considerable shock. One report of somewhat doubtful authenticity gives the value of the shock of the electric eel at about six hundred volts, and while this report may be doubtful it is a fact that a shock is sufficient to completely paralyze the muscles while the current is still flowing. Faraday, the famous physicist, found that the average shock of a fish about four feet long was comparable to that given by a battery of fifteen Leyden jars with a surface of 2.258 square metres loaded to their maximum capacity.

An interesting thing about the eel is that it can, apparently, regulate the power of the current it releases. This may be demonstrated by using an eel which is comparatively tame, in which case the eel will release a small shock if it is stroked or pushed about in the water by its keeper, but will release a paralyzing shock if it is fearful, as when it is about to be moved and finds itself in a net. The only successful way to move such a fish, whose electricity will flow along an apparently perfectly dry wooden net-handle, is to sufficiently disturb the eel for a period of an hour or so to stimulate it into giving off all its electricity, when it may be handled with impunity before it can generate any further supply. This may take about two hours. Further evidence of the regulatory powers is offered when the feeding habits of the fish are watched. It will not eat dead fishes at all, but will send out merely enough electricity to paralyze its potential food. When food fishes with varying degrees of tolerance against electricity are used, the eel after two or three attempts will determine the correct amount of electricity to discharge to paralyze the food, and not kill it, or stimulate it into swimming rapidly away. The eel, in the Aquarium at least, will seldom, if ever, swim after its food, but will lie in wait until the food fishes approach under their own power. After one or two shocks have been released by one eel, in an attempt to feed, all the eels in the tank will swim about the same spot in great excitement, and any food fish which swims out of the immediate vicinity of the active eels is quite safe until it swims before the nose of an eel again.

The eels have, apparently, some special receptor organs for receiving electric shocks and locating their source, for if one eel is stimulated into releasing a shock it will swim rapidly away, and return later, perhaps, to investigate. Before the first one returns, however, all the other eels in the tank will have received the shock and come to the place of its origin to investigate. This was noticed repeatedly, for it was found necessary, because of the lack of interest in searching for food, to wait until one eel was



Dorsal aspect of the electric torpedo brought to the Aquarium from East Africa by A. M. Vida.



Ventral aspect of the same specimen shown on page 134. Brought from East Africa.

within reach and then drop a bit of meat or fish on its nose. It would discharge, seize the food, and decamp; but the other eels, no matter how dormant, or how far away in the tank—which was twenty-eight feet long—would immediately come to the spot where the food was dropped and regular feeding would then take place. A check on this was made repeatedly by dropping a small pebble on the back or tail of an eel, causing it to discharge and swim away, and in every case all the other eels immediately would be swimming about, under the exact spot where the pebble was dropped. There can be no question of markers being noticed by the eels, for the pebbles were dropped through iron grillwork and in different places—sometimes at the head, the back, or either side of the original eel—and the small splash of the falling pebble, or the rings caused by its entrance in the water, had no effect at all unless the pebble actually touched the eel and caused it to discharge. The discharge of electricity by one eel does not otherwise affect the other eels, they probably having a tolerance for each other's shocking power.

The discharge of electricity by the electric catfish, *Malopterurus electricus* of Africa, however, causes considerable disturbance to other electric catfish within range. This phenomenon has been noticed from the first that electric catfish have been observed in aquaria, and all subsequent observations seem to bear it out. Recently, tank space being somewhat at a premium, we tried keeping two of these creatures in the same tank, giving them aquaria which were quite large in comparison to the size of the fish and with many caverns and holes arranged in which to hide separately. We also tried to keep one male and one female together in comparatively large aquaria, but whenever more than one electric catfish were kept in the same aquarium the net result was the same—within a week there was only one alive. In a state of nature the fish must at least pair for mating, but whether they then develop a tolerance for each other's electric powers, or cease discharging electricity, we have no present means of knowing.

The value of the electric power of these fish is somewhat different from those of the electric eel which uses electricity both as a means of catching food and as a defense. The catfish does not, apparently, use its electricity for catching food, but merely as a defense. There is a distinct difference between the feel of the shock

The electric catfish, *Malopterurus electricus,* from Africa. Although the tank was very large the fish congregated in one small cavernous structure of the rocks, a dangerous massing for them since they apparently have no tolerance for each other's electricity.

of the electric eel and the electric catfish. The former is vigorous and prolonged, and if one seizes hold of the fish with the hand, the muscles are contracted and one will be unable to let go again, whereas the shock of the catfish is similar to that from a high tension medical battery —sharp and stinging, but of the shortest duration. In respect to the former kind of shock we have been informed by sailors and collectors of fishes who have brought electric eels to us, that they have lost a good proportion of the collection through persons who doubt the electric powers of the fish and catching hold of the animal are unable to let go. As the muscles of their hand and arm contract, the fish discharges more electricity, which in turn causes a further contraction, only to be broken when the fish has been almost squeezed in two and dies.

The shocking power of the torpedo or electric ray of East Africa, seems to resemble that of the catfish, although this fish uses its power, to some extent at least, in its search for food. One specimen recently exhibited in the Aquarium would stun a small fish with electricity, then dispose its own flat body over that of the victim, and gradually work the stunned fish into its mouth by a series of vigorous undulations of its fins. Specimens of the torpedo are also difficult to procure alive, because of the doubt in the minds of curious persons aboard the steamers which carry the fish back, for the rays are invariably poked and handled until they are exhausted.

In aquaria the electric eel is undoubtedly the best exhibition specimen of these peculiar electric creatures, although it is impossible to exhibit publicly its strange powers.

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FISH-TRADING WITH SOUTH AFRICA

CHARLES HASKINS TOWNSEND

Illustrations from photographs by S. C. Dunton

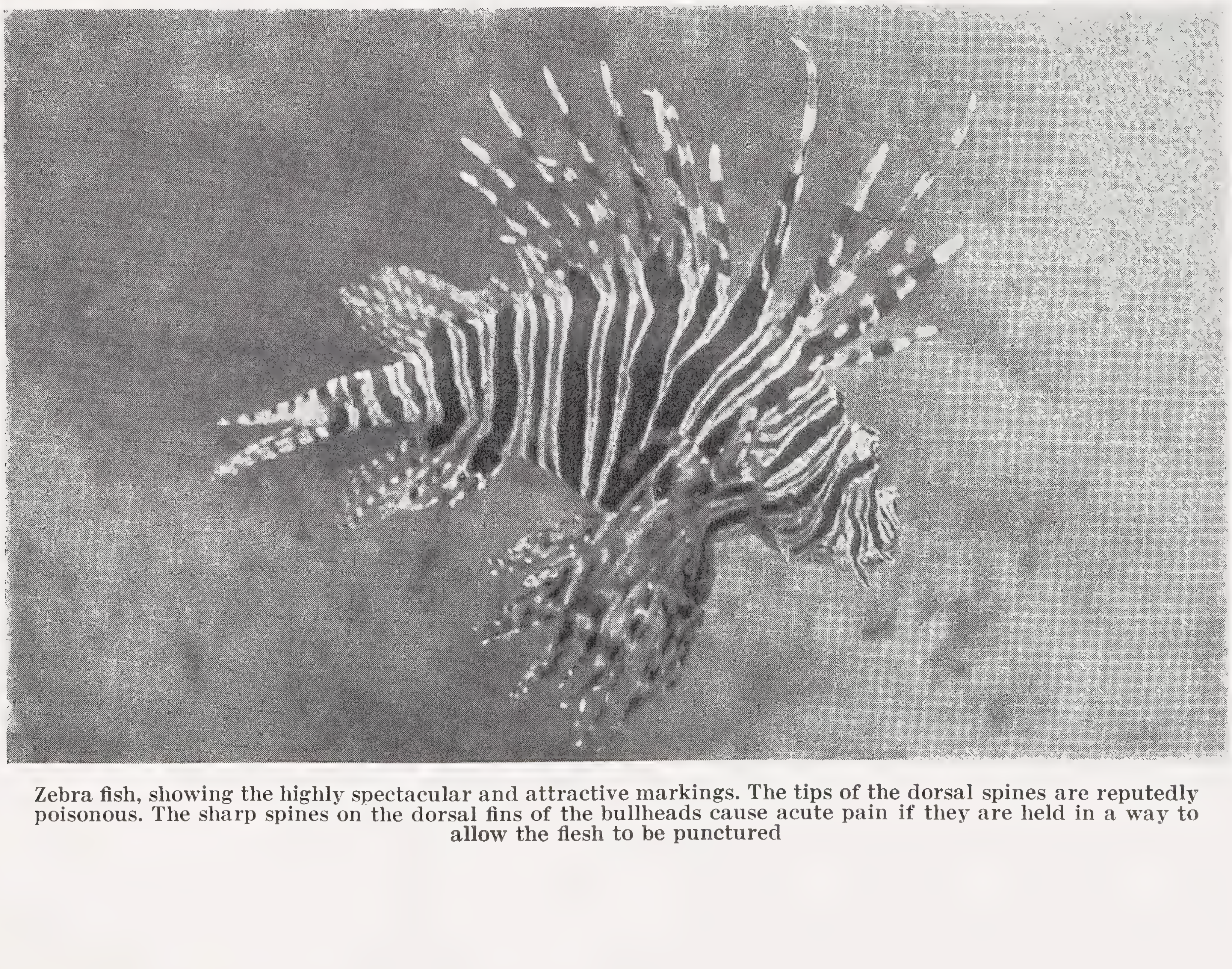
ON October 7, 1932, a telephone call was received at the Aquarium asking if we would accept a small jumping-fish from Africa. We said we would be glad to have such a fish and were then instructed to call for it at a pier in Staten Island. The fish was the well-known mudspringer, *Periophthalmus koelreuteri,* which spends most of its days hopping about mudflats and mangrove swamps catching mosquitoes, and the donor Mr. A. M. Vida, chief radio operator of the American-South African Line Motor Ship *City of New York,* and thus began a most profitable friendship for the Aquarium.

Mr. Vida had carried a number of animals of one sort or another back to New York from his various ports of call. Some of these animals have found their way into American zoological collections, but this was the first time he had attempted to bring back any fishes. He offered to bring any other small fishes he could catch and handle if we would like them. We were, of course, delighted to accept his offer and the ship sailed back to Africa with our high hopes of acquiring African fishes on its return.

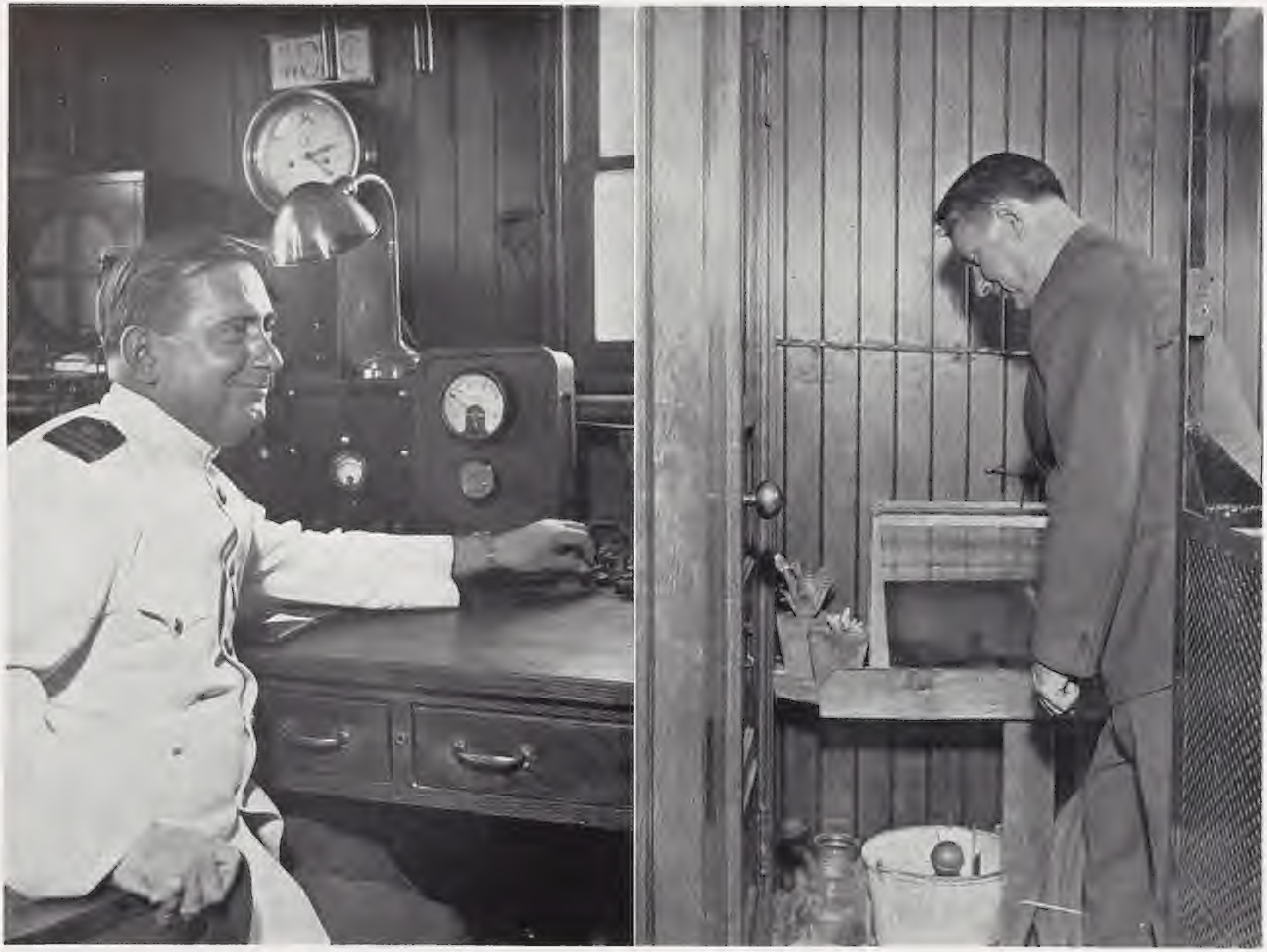
A few small species of African fresh-water fishes are available through commercial channels, the fishes being taken to Germany and either bred there or re-shipped to North America, but it is quite impossible for us to acquire large fishes or marine forms through these professional collectors so that Mr. Vida's offer was highly appreciated.

The *City of New York* returned December 19, 1932, bringing eleven more *Periophthalmus* and one clawed frog. Nothing further was heard from Mr. Vida until June, 1933, when we had a radio message offering us a *Varanus niloticus,* a large lizard. This we accepted and sent to the Zoo, and in discussion with Mr. Vida we found that he had discovered what many other travellers have discovered—that fishes are exceptionally difficult subjects to transport. He had attempted to bring back a number of fishes for us but all had succumbed to the vicissitudes of ocean travel, the only creatures to arrive safely being those which required little water. However, Mr. Vida was still willing to try and was confident that he could successfully carry fishes back for us.

With the permission of the ship's officers, Captain George M. Wauchope and Chief Officer Paul S. Maguire, the Aquarium installed a series of six twelve-gallon aquaria on the ship, the American-South African Line kindly building a wooden rack in the radio room to carry these. The Aquarium also installed a small air pump so that the water might be easily aerated, and another attempt to carry fishes was under way.



Zebra fish, showing the highly spectacular and attractive markings. The tips of the dorsal spines are reputedly poisonous. The sharp spines on the dorsal fins of the bullheads cause acute pain if they are held in a way to allow the flesh to be punctured

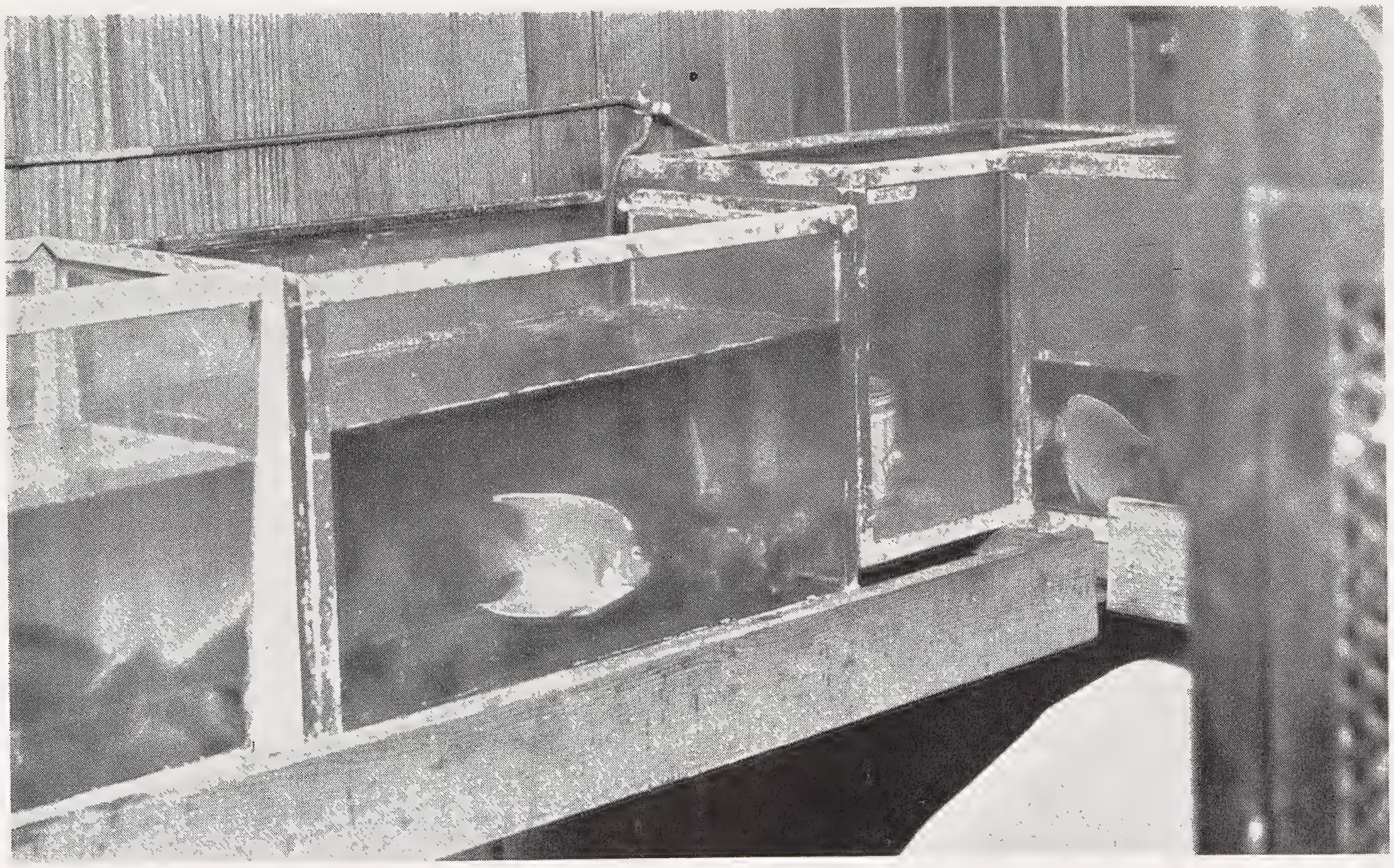


Left: Mr. A. M. Vida, chief radio operator of the Motor Ship *City of New York* sitting at the radio key. *Right:* One of the series of aquaria built around the radio room. A corner of the radio transmitter at the right indicates the close quarters in which Mr. Vida works.

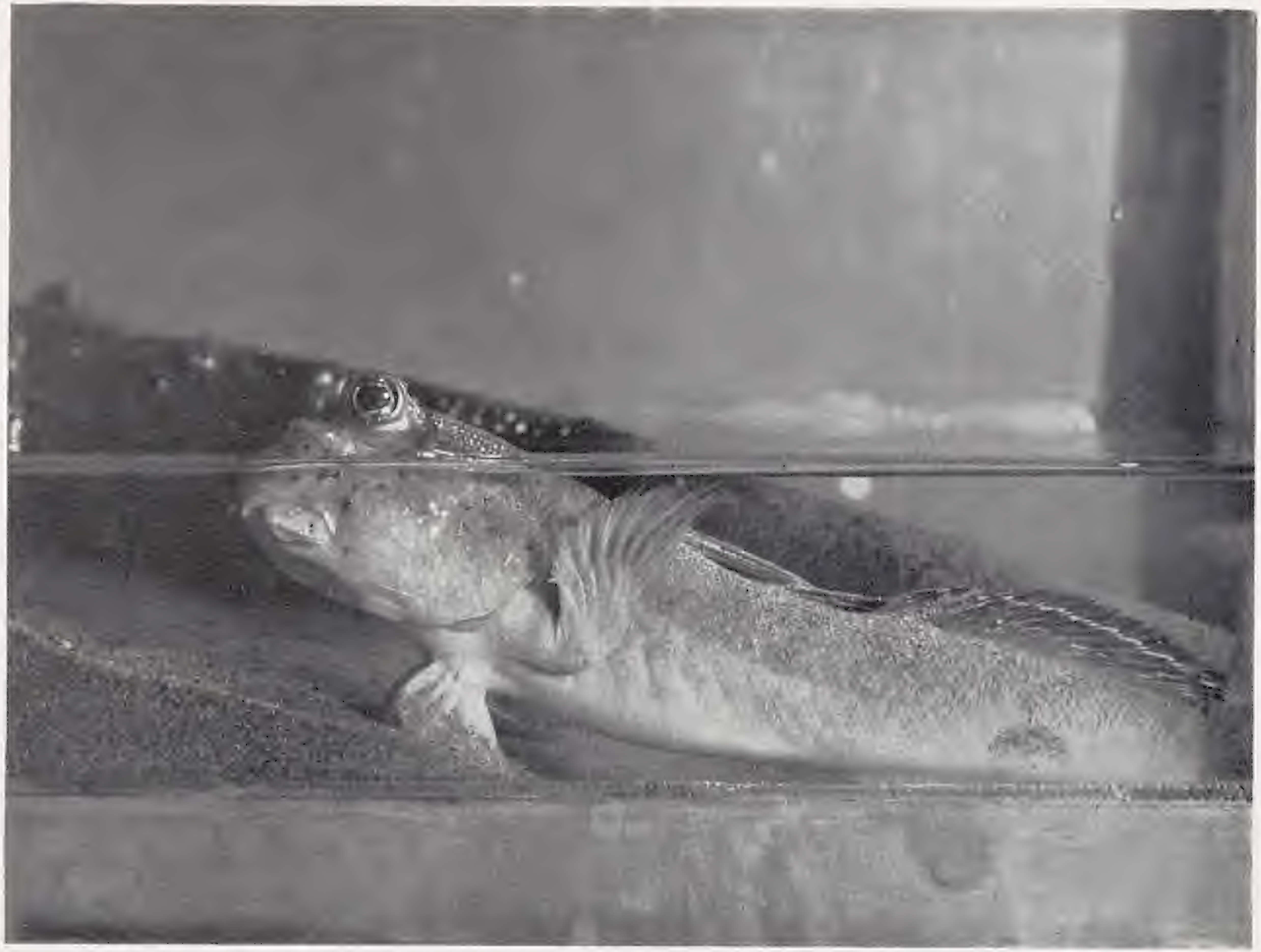
On this trip, Mr. Vida took with him a number of small local marine fishes as a gift to the East London, South Africa, Aquarium. This institution was desirous of obtaining American forms. These fishes were successfully transported and in return, Dr. Nanni, Director of the East London Aquarium, gave Mr. Vida some fishes for us. These included the spectacular zebra fish, *Pterois volitans,* and it was on this trip that Mr. Vida had the difficulty in feeding them referred to elsewhere in this issue. The zebra fish are exceedingly rare in North America and have a high cash value. At present the zebra fishes at the Aquarium are about eight inches long and make an exceptionally attractive display. Besides the zebra fish, a number of glass fish—small transparent creatures that look as if they are made of glass—and an assortment of rare cichlids which Mr. Vida caught in the tidal waters near Beira, Portuguese East Africa, were donated. One lung fish also was received. This fish, which breathes air, was carried from the African interior in a gunny sack and immediately demonstrated his pleasure at being in the water again by eating a smaller lung fish which was already in the tank in which he was placed.

On Mr. Vida's return to Africa after this trip he took with him another small collection of West Indian and local marine fishes for Dr. Nanni's collection. During this eastward leg of the voyage, the ship called at the Island of St. Helena and Mr. Vida added a number of local fishes to his tanks. Part of this collection was given to the East London Aquarium and part brought back to New York. Our share of these included a number of Five Fingers—a species of *Abudefduf* which derives its local name from the grayish bands across its body which look as if they were the imprints of a clutching hand;—two very lovely green fishes, and a number of terapon. In exchange for our fishes, Dr. Nanni gave Mr. Vida two black-footed penguins and a number of fishes. This consignment arrived safely in spite of a very stormy and cold crossing, reaching the Aquarium, via Boston, in December, 1933.

A further collection of African and St. Helena fishes reached us in March, 1934. This, comprising 138 specimens of eighteen species, was the largest to come to hand, and included one lung fish, one electric torpedo, some new climbing perch, and a collection of young fishes of species rarely, if ever, exhibited in America. Mr. Vida, however, reported that he had not enough



A corner of the radio room of the Motor Ship *City of New York* showing part of the series of aquaria and some Angel fish from the New York Aquarium enroute to the East London, South Africa, Aquarium.



The odd-shaped mudspringer, *Periophthalmus koelreuteri*, showing the position assumed by the fish when at rest. The weight of the body is supported by the ventral fins and tail. One of the angulated pectoral fins, on which the fish jumps about, is clearly visible just behind the head, bent backwards and upwards.

tanks to carry the fishes available to him, and so, with the permission of the ship's officers, two fifty-gallon tanks were installed on the after part of the bridge deck of the liner.

Again a small collection of local fishes were sent to East London Aquarium, and Dr. Nanni reciprocated with an octopus and six small zebra fish. Mr. Vida also made a collection of fishes in St. Helena, Beira, Lourenço Marques and Durban, but this trip was not so successfully completed for the radio apparatus went out of order and the fishes could not be attended to as much as they required. The zebra fish, some clown fish, an African porgy, a carabella, and some infant groupers being all that travelled safely.

At the various ports of call a number of native fishermen have been enlisted by Mr. Vida to collect fishes for us. These men will be paid in the most valued medium of exchange in their locality, which varies from cigarettes and candy to old overcoats and suits of dungarees, such articles apparently having greater value than currency. Already several outworn garments have been changed, through the agency of Mr. Vida, into very attractive exhibits.

At the present writing four penguins and a number of fishes are aboard the Motor Ship *City of New York* en route to the New York Aquarium. These are due here about mid-October. We are very much indebted to Mr. Vida for his efforts on our behalf and to the owners and officers of the vessel for their interest and assistance.

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THE ULTIMATE IN TAILLESS FISH

C. M. Breder, Jr.

PERSONS that are concerned with the handling of fishes in one way or another encounter from time to time individual specimens that evidently have been seriously injured and recovered with only a scar or some deformation to tell of some old time misadventure. Among such cases are specimens that have lost the tail fin completely or in part. Superficially these are rather striking since the caudal appendage is so intimately associated with underwater locomotion. It is evident that, nevertheless, these fishes are able to survive despite this apparent handicap. Scattered through both scientific and lay literature pertaining to fishes may be found numerous references to specimens mutilated to this extent that were caught along with normal members of their kind. Probably every ichthyologist has seen one or more case of this sort and many have considered them of sufficient interest to warrant a report. The present contributor in looking over old papers finds that he has previously mentioned two such cases, one a Panamanian creek fish, *Piabucina festae*[1] and the other a mention of numerous instances of the kind in the pearl roach, *Scardinius erythopthalmus* which appeared nine years ago in this Bulletin.[2] One of the most interesting of such instances was mentioned by J. T. Nichols[3] concerning a large tarpon, to mention only one reference to the literature of the subject.

The origin of these injuries is clearly caused in the main, if not entirely, by predatory forms biting entirely through the posterior portion of a fish they had attempted to catch. The dying fore parts of a fish is not an uncommon sight where predatory forms are active, as can witness any West Indian fisherman, who frequently, to his dismay, draws up part of a fish on the end of his line. Usually this is evidence that some passing shark has helped itself. Sometimes the fisherman gets only a head and sometimes sharks are too abundant and active to make continued fishing worth while. Fishes injured this way were clearly in distress, having been hooked before being attacked, but it is not an uncommon sight to find similar cases of free fishes sharing a like fate. This is especially evident in the case of schooling fish when active predators slash right and left among them. Of course only those few with no vital organs destroyed stand a chance of surviving. Of the latter, it would

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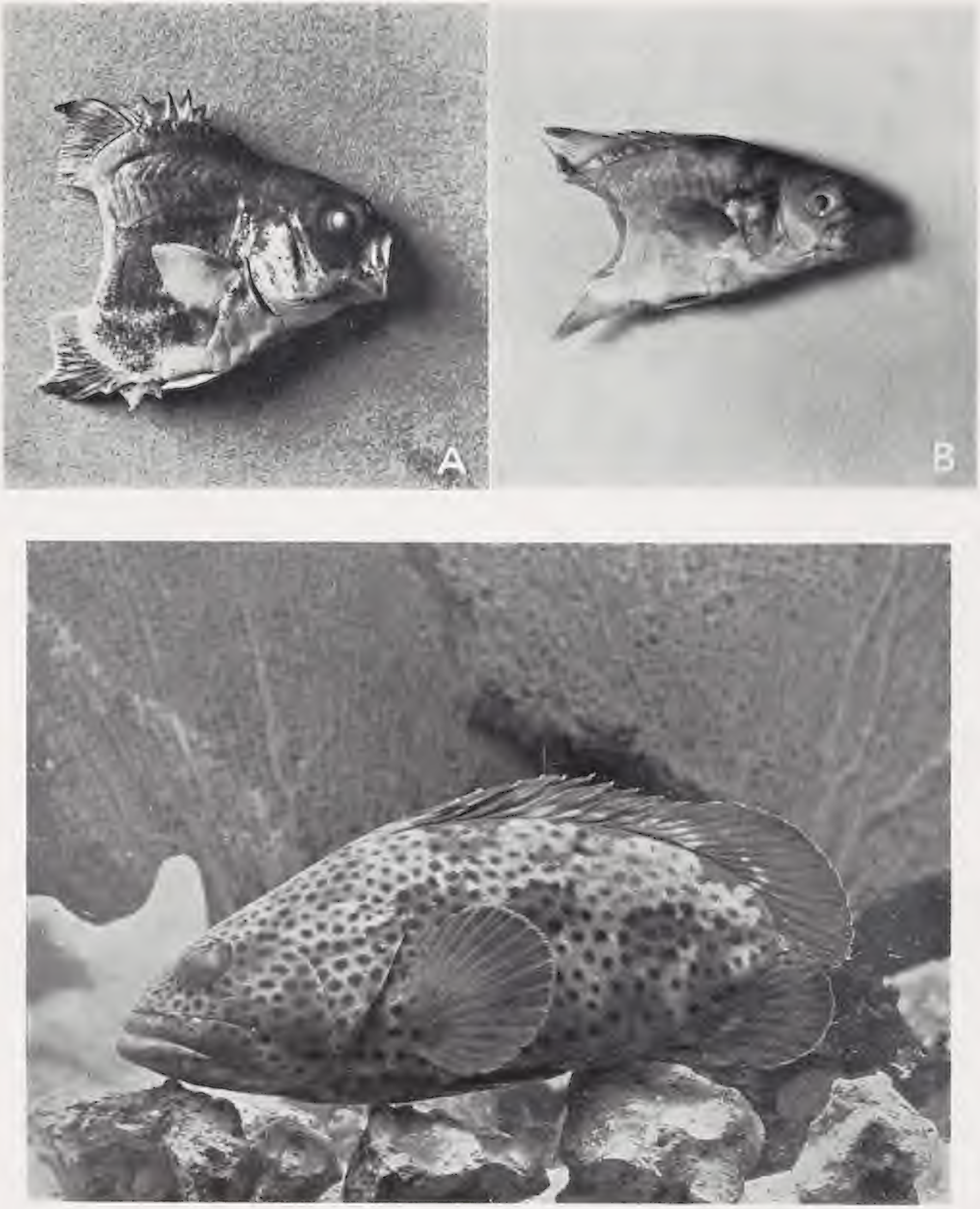
[1] Breder, C. M. Jr., 1927, The Fishes of the Rio Chucunaque Drainage, Eastern Panama. Bull. Amer. Mus. Nat. Hist. 57 (3) :91-176.

[2] Breder, C. M. Jr., 1925, Tailless Pearl Roach. Bull. N.Y.Z.S. 28 (3) :72-74.

[3] Nichols, J. T., 1921, The Miami Aquarium. Nat. Hist. 21 (4) :359-366.



(a) A tailless round pompano, *Trachinotus falcatus.* The injury resulting in the loss of the tail had completely healed and the fish was active and alert. It swam rapidly by employing the dorsal and anal fins for purposes of propulsion. This fish measured 38 mm. over all. (b) A specimen of the common pompano, *Trachinotus carolina* wounded by a young bluefish. This specimen was found in a dying condition as were several others after the passage of a school of snappers. Note the similarity to the injury on the round pompano that survived. (c) A tailless red hind, *Epinephelus guttatus.* This specimen taken at Key West, Florida, had evidently lost its tail in its early youth. Note how both the dorsal and anal fins have grown backward and form a substitute for the lost tail fin. This fish lived for about a year and a half in the Aquarium, and was able to hold its own with normal tank mates. Photographs (A) and (C) by S. C. Dunton.

seem that few of those could compete with whole, uninjured fishes but the fact is, nevertheless, a percentage evidently do. Bearing on this are some observations made on the relative speeds of tailed and tailless pearl roach. At no time could any difference in speed of swimming be noted by the writer between two such fishes. The difference noted was that the tailless one swung its stump through a wider arc which it could more easily do, being minus the resistance of the fan-like tail. This was discussed with some hesitation in a technical paper on fish locomotion.[4] Since then this subject has been studied in experimental detail involving the use of motion pictures for analysis by Dr. J. Gray[5] of Cambridge, England. It is with considerable satisfaction that it may be reported that his studies have borne out these superficially unlikely observations.

Since the above mentioned matters were discussed in print, two other cases came to the author's attention on looking over incoming specimens at the New York Aquarium. One, a hind, *Epinephelus guttatus* (Linnaeus), is illustrated herewith and shows the deformation very well. In this case the posterior portions of the dorsal and anal fins grew longer and drew around rearward, replacing to some extent the lost tail fin. This occurs only in fishes of the "ordinary" fish form such as the one illustrated. The other case noted above was a large green moray, *Gymnothorax funebris* Ranzani. This fish with its simple eel-shape presented no such peculiarity but was simply truncate behind and nearly a third shorter than others of its same diameter.

The occasion of the present remarks, however, does not concern the above fishes but refers to a truly remarkable specimen received at the Aquarium during the preparation of this Bulletin. As the title suggests it is certainly the ultimate in tailless fish. This specimen, a young pompano, *Trachinotus falcatus,* as shown in the accompanying photograph, not only lost its tail but the major portion of the posterior part of the body as well, and parts of the dorsal and anal fins. If the wound had been ever so slightly forward of where it is, the vital organs would have been involved and no such curiosity would have reached us. The skin had completely covered the wound caused by the severance of the after parts of the fish.

The outline diagram illustrates the physical difference between this abbreviated specimen and a normal pompano of like size. It is to be noted that the depth of the body has increased somewhat, due presumably either to a bunching of the muscles after their severance or to their greater development because of some unaccustomed strain being placed upon them. The forehead thus appears to be somewhat concave. The form of both the dorsal and anal fins differ from the normal, so that most of their extent is along a vertical line. In this position they are able to offset the loss of the tail fin to an effective extent. This fish had completely healed its wound when it was brought to the Aquarium in a living, active state from Islip, Long Island, by Mr. K. Atwood 3rd. Although it died a few days later there is no reason to associate its demise with the fully healed wound. It may be mentioned that fishes brought in by persons unfamiliar with the technique of caring for marine specimens, although always appreciated, frequently die in a short time.

Some years ago the writer discussed the growth and behavior of young bluefishes in these pages.[6] In this connection there was figured a young common pompano, *Trachinotus carolinus,* that had been nearly bitten in half. This specimen was nearly dead when found as were numerous others. The illustration is here repeated for comparison with the specimen under discussion. It is difficult to avoid the conclusion that this one too was snapped at by a "snapper blue." It so happens that in local waters there are no other common fish that would be likely to snap a fish in two in just such a fashion.

The development of the remaining vertical fins in fishes so injured is, perhaps, the most interesting feature of them. If the dorsal fin is far forward and only the anal fin far back enough to be involved, this tends to turn up and replace the lost caudal fin. The tarpon, pearl roach and *Piabucina* previously referred to rep-

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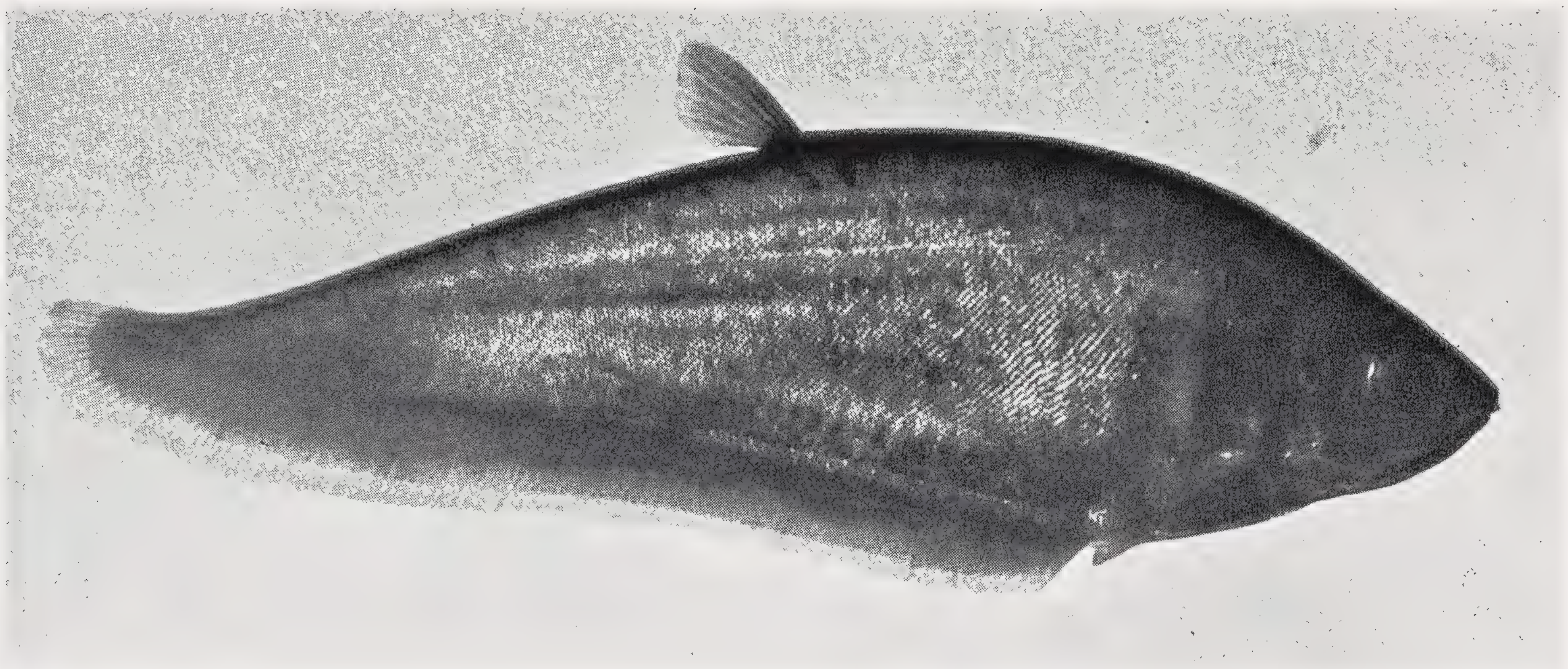
[4] Breder, C. M. Jr., 1926, The Locomotion of Fishes. Zoologica 4 (5):159-297.

[5] Gray, J., 1933. Studies in animal locomotion III. The propulsive mechanism of the whiting (Gadus merlangus) Journ. Exp. Biol. 10 (4):391-400, 1933. Directional Control of Fish Movement. Proc. Roy. Soc. London, 113, 115-125, 1933. The muscular movements of fishes. Proc. Roy. Instit. Great Brit. April 28:1-32.

[6] Breder, C. M. Jr., 1925. Growth of young bluefish. Bull. N.Y.Z.S. 38 (6):181-183.



The featherback, *Notopterus afer*, a fish that has the anal fin fused with the caudal in such a fashion as to suggest the direction in which a tailless fish with a long anal tends to develop. Photograph by S. C. Dunton.

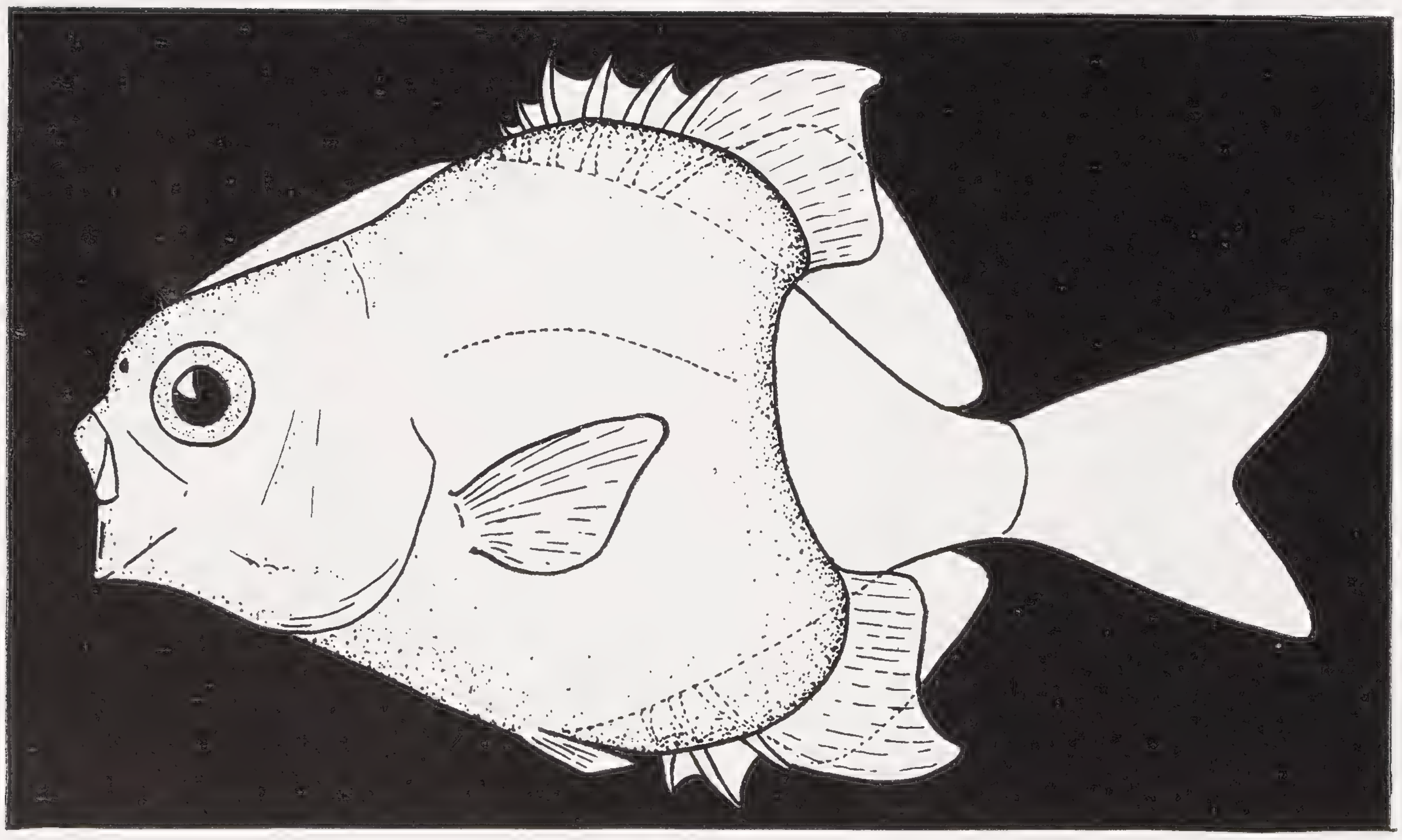
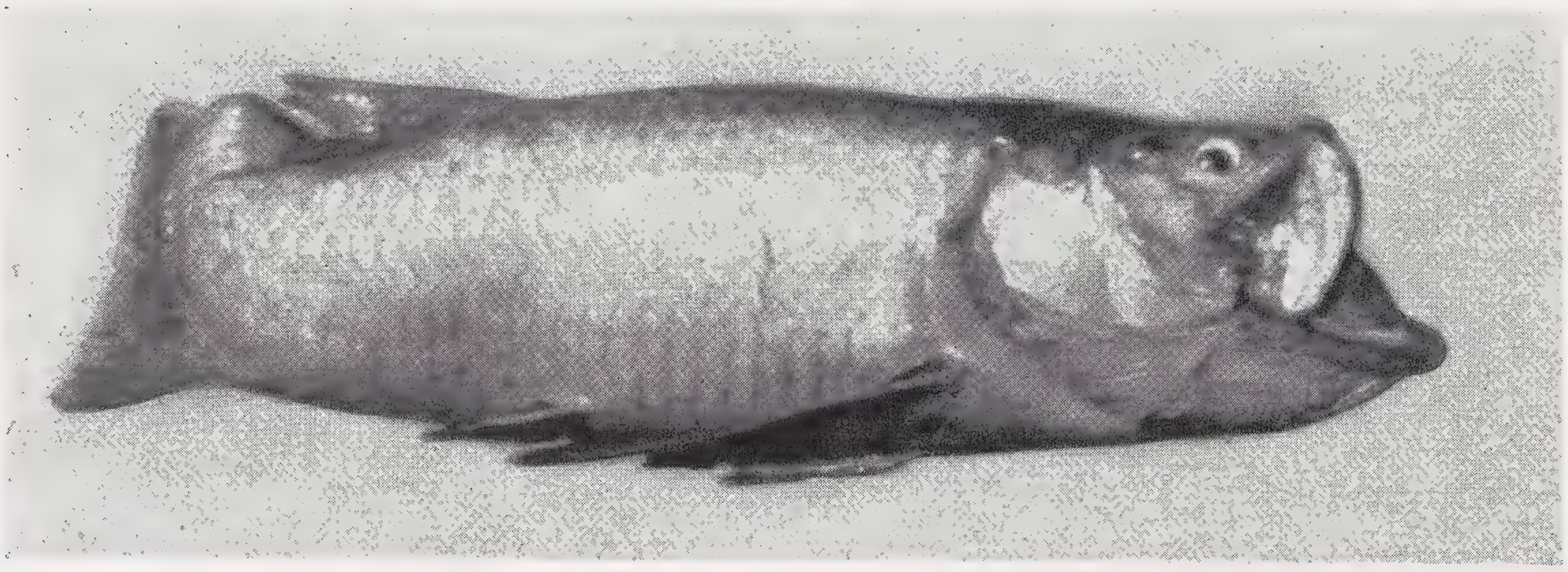


Diagram of the tailless round pompano (a) shown in the accompanying photograph on page 142. This is overlaid on the outline of the normal fish for purposes of comparison.



A tarpon, *Tarpon atlanticus*, that has lost its tail and in which the anal fin serves in its stead. Compare this figure with that of the normal featherback above. After Nichols (1921).

resent such cases. Fishes in which both dorsal and anal are involved as the hind and pompano, here illustrated, show the anal growing up and the dorsal down. In the first type the vertebral column deflects upward but in the second it remains horizontal, being acted upon about equally from both directions. As Mr. Nichols has pointed out the tipping up of the vertebral column suggests the mode of evolution of the normal fish tail. In primitive bony fishes this column extends along the dorsal edge of the tail and while relatively retracted in the advanced forms still retains the tipped up condition internally.

In various fishes that have a pointed or acuminate tail the regeneration is usually quite normal if the severance has not been too far forward. The African lungfish, *Protopterus aetheopicus,* and the knifefish, *Gymnotus carapo,* are examples of this sort. All this would suggest a study in the stresses and strains of a mechanical nature set up in a body composed chiefly of structural supports (bones), lashed together with elastic thongs under tension (muscles). The parts left, when some elements are removed, then realign themselves according to physical laws, upon which are superimposed a development along new lines dependent on what way the organism attempts to exercise its remaining parts to compensate for those lost. Any cripple, human or otherwise, operates along this same pattern with the consequence that both bones and muscles become developed in unexpected ways. These are "unexpected" only in so far as we are unable to follow the structural significance of the numerous interlocked parts of a vertebrate. If these were sufficiently understood we could doubtless prognosticate just what development would follow the removal of a given element. In this connection the form of the featherback, *Notopterus afer* is pertinent in that it normally bears a marked superficial resemblance to tailless fish in which the anal fin only replaces the caudal. This fish has a notably small and forwardly placed dorsal and a long anal fusing with the tail fin. Very likely if the mechanics of the deformations discussed were thoroughly understood such information could be applied with profit to the study of the development of the great diversity to be found in the body form of fishes.

THE NEWFOUNDLAND SEAL FISHERY

Charles Haskins Townsend

In *Science* for August 24, Dr. C. Hart Merriam called attention to an announcement by the secretary of the Society for the Preservation of the Fauna of the Empire that the Newfoundland sealing industry is steadily declining and recommending that a sanctuary be provided for the protection of the seals. Dr. Merriam very properly pointed out that these ocean-dwelling seals breed only on ice floes and that a land sanctuary would not be possible.

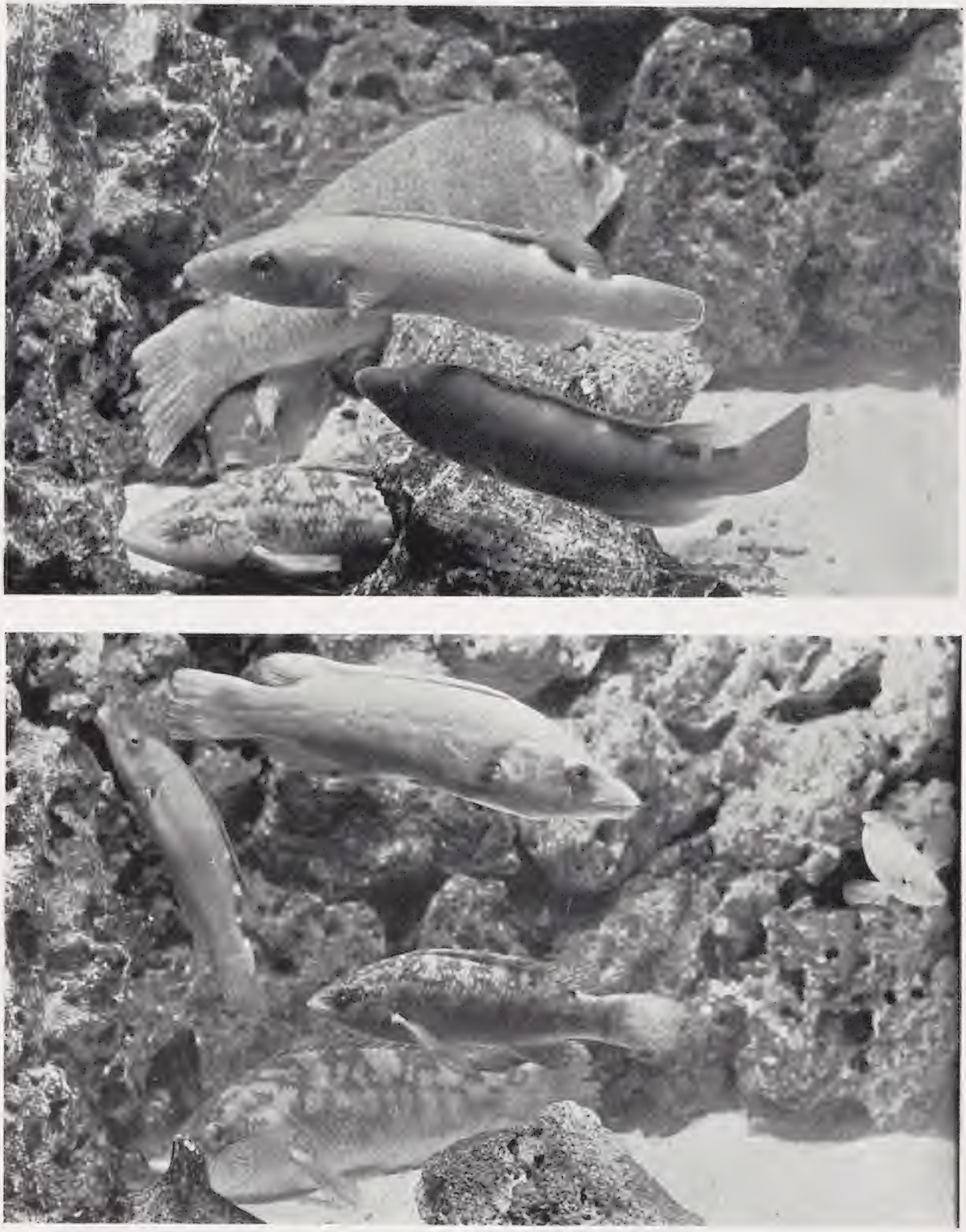
Having before me the official records of the catch of the Newfoundland seal fishery for over 100 years, it does not appear that the fishery has declined to a serious extent. During the period from 1860 to 1930 the average annual catch was 196,019. Due to unfavorable weather conditions in 1931 and 1932 there was a falling off, but in 1934, 223,708 seals were taken.

Prior to the middle of the nineteenth century large numbers of sailing vessels engaged in this fishery. At one time in the 'fifties, there were 400, it is said. The annual catch *occasionally* exceeded half a million seals. Later, when the sailing vessels were replaced by steamers, the hunting season was officially shortened with a view to conservation.

Sealing operations are now permitted only between March 10 and April 15. Owing to the present low price of seal skins and oil only nine steamers were employed in making the large catch of 1934,—223,708 seals.

This long established seal fishery is unique in that it is based on the taking of *young* seals only, the number of adults captured being negligible. Adults take to the water at once, upon the approach of the hunters, the extremely fat, nursing young being unable to leave the ice floes on which they are born.

The catch has always been made on ice floes not far from Newfoundland. Doubtless both harp and hood seals, the two species on which the fishery is based, bring forth their young on ice fields more remote and impenetrable by vessels. It is evident that the survival of great numbers of breeding seals has hitherto sufficed for the notably prolonged maintenance of the fishery. I have records of catches dating back to 1795. With no heavier killing than that of the past decade the fishery may last indefinitely.



Upper: Two female red wrass, *Labrus ossifragus* showing a light and dark color phase and in the background two ballan wrass. *Lower:* A male red wrass, *Labrus ossifragus* (upper center). The very differently colored female is seen to the extreme left. There are two ballan wrass below.

We have for some time urged that the control of sea lions on the Pacific Coast be brought about by commercial use of the nursing young before they are old enough to take to the water, rather than by wanton destruction of breeding sea lions that sink when shot. Young sea lions represent a resource in usable leather and oil that has hitherto been wasted, the skins of adults not being utilized.

A COLLECTION OF FISHES FROM SWEDEN

Charles Haskins Townsend

Illustrations from photographs by S. C. Dunton

IN the Marine Museum of Gothenburg, Sweden, there is located a public aquarium. This display occupies the basement floor of the Museum building and has on view a variety of local and foreign fishes and a collection of local invertebrates.

From time to time this institution, which is directed by Dr. H. Ostergren, has exchanged specimens with the New York Aquarium. Usually these exchanges have consisted principally of invertebrates, the European institutions being particularly interested in obtaining the common Atlantic coast horseshoe crab which is not native to European waters and which has a significant scientific interest because of its resemblance to the long extinct trilobites.

It so happened this summer that one of the Aquarium employees, Mr. A. Olsen, arranged to visit Sweden. From New York he took a variety of marine fishes as well as horseshoe crabs as a gift to the Gothenburg Aquarium. On his return he brought to New York an interesting number of specimens of northern European species that heretofore had not been exhibited in our Aquarium.

The wrasses (*Labridae*) which are represented in local waters by only the drab tautog and the bergall on the northern coasts of Europe are represented by a variety of species, many of which compare with the more brilliant tropical members of this family found only about coral reefs.

One of these the so-called red wrass (*Labrus ossifragus*) is a long slender fish of a rather pleasing shade of maroon. That is the females are so colored. The males, however, until not so very long ago thought to be a different species, are most decidedly not red. Instead they are marked with a number of irregular brilliant green stripes.

Among the invertebrates was the large crab (*Eriocheir*) a rather striking crustacean superficially resembling our stone crab of the Florida coast, as well as a variety of sea anemonies and starfishes. We are greatly indebted to Dr. Ostergren for his kindness in making possible the display of these fishes in the New York Aquarium.

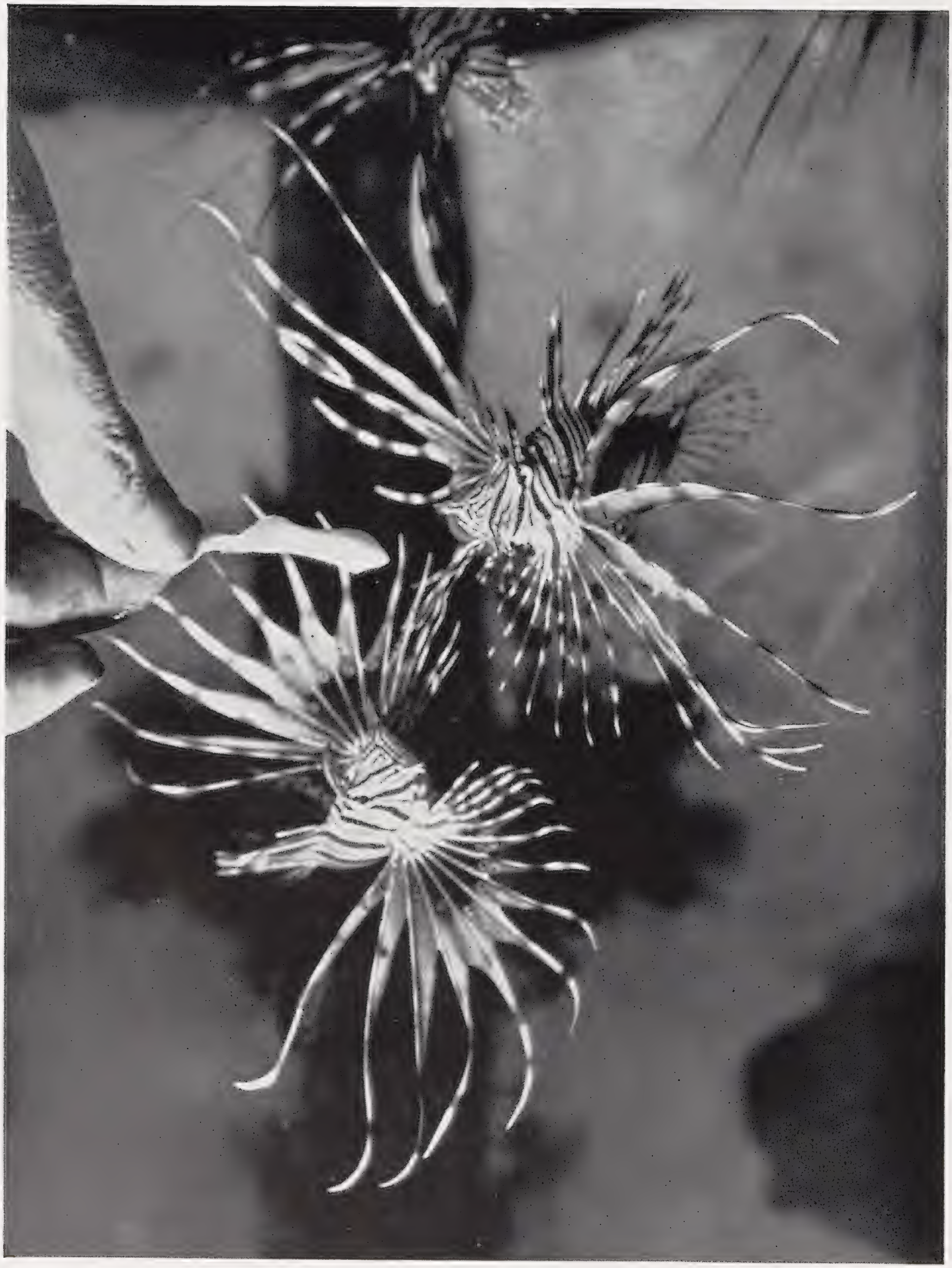
FEEDING AQUATIC ANIMALS

The difficulties experienced in the selection and maintenance of a proper diet

C. W. Coates

Illustrations from photographs by S. C. Dunton

IN any large and diverse collection of animals from many different localities there must of necessity be a considerable adjustment of the dietary requirements of the creatures maintained. It is not possible to reproduce in any one spot on the earth conditions obtaining in all the others. To secure the food which each animal finds in its own habitat is out of the question from a practical standpoint, although, if such foods were available it would be a good deal easier for the keepers of the animals than it sometimes is for them to find a suitable substitute. If they are not successful in finding a suitable substitute food they must stand by helplessly while the animal endeavors to make its own adjustment to the food available;—a most unpleasant situation for the good animal man. However, most animals can be trained to eat the foodstuffs available with a little care and coaxing, or if they cannot be coaxed into eating before they are in actual danger of starvation, may be forcibly fed until they find that the food offered them is palatable and their natural will-to-live is stimulated. One example which is frequently before us in the Aquarium is afforded by the small alligators brought us from Florida by well-meaning tourists. A great many of these are unintentionally badly treated and are in extreme straits when they are offered to us, and, invariably will eat nothing. However, after their mouths have been opened gently and a bit of raw beefheart pressed on



Feeding zebra fish. The photograph was taken from above the surface of the water. These fish, which normally will eat only living food, have been conditioned to dead food and take it readily. These were the first of this species to be brought to the Aquarium by Mr. Vida.

their tongues three or four times, they start to eat everything offered and will then fill out and grow rapidly. So many of these are received *in extremis* and saved by this short period of forcible feeding, that we frequently have sufficient to ship some off to public aquaria in Europe in exchange for native fishes of one sort or another.

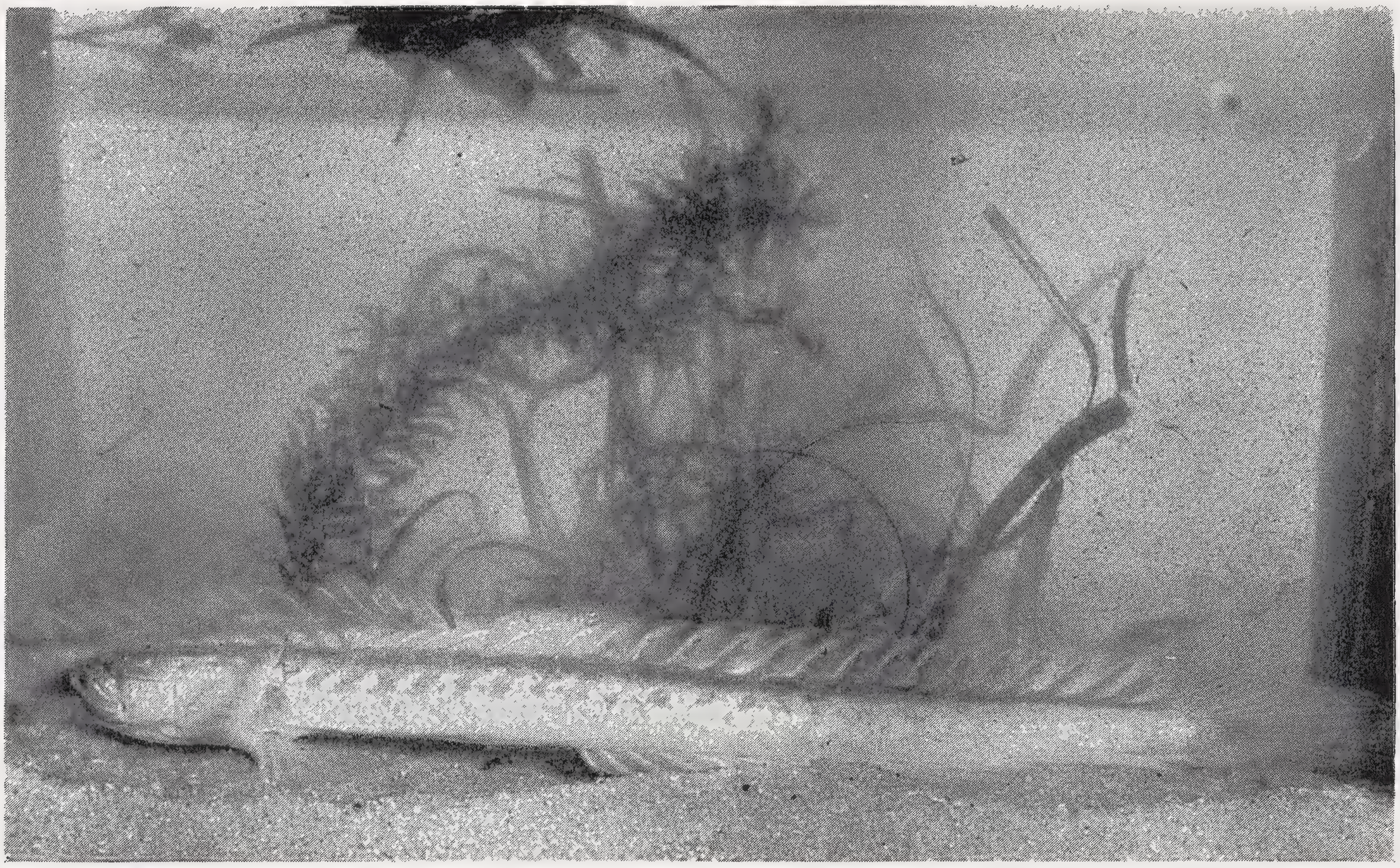
Baby cayman, which are sometimes received, are much more difficult to handle. These South American beasts are exceptionally vicious and ill repay the care they get. They will refuse food for months. Very young creatures have no reserve to carry them through these long periods of fasting and must be fed forcibly, although unless the food is passed behind the epiglottis and well into their throats they will eject it consistently. However, after six or eight weeks of this sort of feeding they recover their health and unpleasant temperament and then present another problem, for they cannot be kept with other crocodilians of similar size without continually fighting with them. Even large cayman are just as difficult, with the added disadvantage that they cannot be forcibly fed so easily. One fourteen-foot cayman recently exhibited here refused all food for six weeks after and about eight weeks before he arrived at the Aquarium. This particular problem was solved by treating him to about thirty minutes of ultraviolet rays and then offering him a beefheart. He would take it immediately after being treated with the special light, but it was not until after six weeks of this treatment that he would take food which was offered without the preliminary light bath.

Some of the fishes present different problems. Many of these are accustomed to catching their own food alive, and since this is usually out of the question in the Aquarium, other devices must be resorted to. When the Zebra fish now on exhibition were brought from South Africa, the supply of killiefishes on board ship ran out and Mr. A. M. Vida, who was looking after the fish for us, radioed frantically for instructions. Various types of food were offered and refused until strips of the white of hard-boiled eggs were dropped into the tank. These slowly sank through the water with a wavy motion and effectively deceived the fish. They arrived here in good condition and are now so tame that they will take any food offered from the attendant's fingers. Incidentally they have grown, in less than one year, to about four times the size they were when received.

Some other predatory fishes never become accustomed to dead food, although the savage piranhas are successfully deceived by a bit of fish or beefheart suspended from a length of string and kept moving a little. Sometimes recently acquired piranhas will not eat unless the food is moving, although two or three specimens which have been in the Aquarium for two years or longer will take anything offered, even if it is lying on the bottom of the aquarium, and ignore moving food if the pieces are larger than they are in the habit of getting.

Fishes that are not predators also cause some difficulty and may easily be starved to death with food all around them unless care is taken that they are sufficiently supplied with the proper type. The *Loricariates* will starve unless they have a large supply of algae to graze over. We have found that the most practical method of providing this is to keep several pieces of rock in water where there is a great deal of light until the rock is covered with algae. These are then placed in the tanks with the fish, the cleared pieces being removed. Such a piece of rock will be cleaned of algae within a day or so and will then have to be replaced. We had hoped, at one time, to use these fishes with their large sucking mouths to clean algae from a number of different exhibition tanks, but found that they could not condition themselves to the different waters rapidly enough to be of much value.

Some of the fishes, such as the blue scalare, feed only at night and from the bottom of a tank. Since it is impossible to give each species of fish a separate tank, it is necessary to find tank companions which will not interfere with these feeding habits, so fishes which feed primarily on floating or swimming foods during the day are the most suitable. Fortunately the related and similarly shaped silver scalare fulfill the requirements in this particular case. They are fed on food which floats, while the blue scalare finds its nourishment in the food that sinks. In tanks in which there are many different kinds of fishes all eating approximately the same food, those fishes which are



A Gobioides from western South America. The vicious-looking mouth is apparently quite deceptive, as far as we have been able to discover, since it is used apparently for nothing more dangerous than scooping up quantities of detritus from which the fish separates the foods that it requires.

most active will take everything offered and the slow ones will not find enough to eat. This is remedied by feeding all the fishes as much as they will consume immediately and then, in five or ten minutes, returning with a little more food. Almost invariably the fast feeders have gorged themselves and do not interfere with the second feeding. It might be necessary to explain here that it is dangerous to the fishes to leave uneaten food lying in most tanks, for this will sometimes form the nucleus of serious infections.

Some of the fishes which are apparently carnivorous require at least some vegetation. If this is not supplied to them they will tear up and eat any growing plants they find, or die if they find none. Like cattle, however, the fish do not seem to mind whether the vegetable matter is fresh or dried, for they will eat the yellowed leaves of dried aquatic plants as readily as they do freshly-growing ones. These latter keep them in the best condition. Most of the small fishes may be fed on chopped beefheart or fish, although they do not always thrive on this diet. Living worms of various sorts and sizes have proved to be the best staple diet for the majority of our fresh-water tropical specimens, but adjustments and differences in kinds of food and time of feeding must be continually made.

Many specimens of one species, *Pantodon buchholtzi,* from Africa, will starve to death unless living cockroaches are given to them, although wherever they acquired such a taste no one knows. Most of the specimens ever brought to this country have steadfastly refused other food as a steady diet, but will take an occasional earth-, meal- or wax-worm. These worms are not always completely eaten by the fish and will cause serious trouble if left in the tank. Other fishes which catch winged insects flying above the water may be successfully trained to a diet of dried foods by feeding them for a week or two on mosquito larvae, for another period with larvae mixed with dead food, and then dead food or worms alone. Losses among these fishes will occur unless each individual is watched to see that it is taking its share.

Some specimens, no matter how peaceable the species, will eat their companions unless they are especially treated. When such cases develop the fish which shows the slightest ill-will toward other fishes in the tank must be removed at once.

FEEDING YOUNG FISHES

The Cultivation of Minute Crustaceans as an Important Part of Foods for Fishes

R. F. Nigrelli

Illustrations from photographs by S. C. Dunton

THE question of obtaining minute living organisms in sufficient quantities to feed very young and small fishes, has long been an important problem at the Aquarium. For many years *Daphnia,* brought in by professional collectors from ponds in nearby areas, has been used extensively for both the northern and tropical fresh-water fishes present in the Aquarium. Such collections, although very plentiful during the summer months, become very scarce in the winter, due for the most part to the freezing over of the ponds.

For the past year or so we were successful to a certain degree in cultivating this small crustacean. Employing the standard method of cultivation the yield was not very great, but sufficient numbers of them were obtained all through the winter to feed a few of the more delicate species. However, more recent experiments on growing these crustaceans gave us greater yields. Thus, two large reserve tanks were filled with water. Several liters of hay and oat infusion were introduced, and when a heavy growth of infusoria had developed, the tanks were inoculated with *Daphnia* collected from a pond. In a short time (four weeks) the organism had reproduced in large numbers. It is a well-known fact that crowding has ill effects on reproduction; the excretory products being very injurious. To avoid these effects part of the heavy growth of *Daphnia* were inoculated into fresh tanks. In this manner we were able to keep a large supply growing constantly. Suspensions of yeast cells, as was suggested by Bond (1934),[1] were introduced at intervals of every three days, as a constant source of food for the *Daphnia.*

This season the Aquarium has again attempted to hatch and grow several species of fishes which are very difficult to bring to full development. With such a source of food on hand we were particularly successful in carrying several species of fishes over their critical period of growth. Most all fishes that survive the larval stage require some small organism as food. Although dry food will suffice in many instances, it was found that the fishes would grow more rapidly when fed live *Daphnia* and tubifex worms. This was especially true in the case of catfish, spawned and hatched in the Aquarium. Incidental feeding experiments with dry and live food showed a large difference in the size of these fishes at the end of one month. Mr. C. W. Coates has reported similar results for many of the small fresh-water tropical fishes. Again, the Aquarium was successful in hatching and rearing whitefish and the European bitterling. Our first attempt at hatching muskallunge eggs was also successful. The latter individuals are very delicate, and in their initial growth period such food as *Daphnia* is very important for survival.

For the marine fishes that are plankton feeders, the Aquarium collector brought in *Gammarus* from the shores of Long Island and Sandy Hook regions. This crustacean, although much larger than *Daphnia,* is caught one by one among the rocks washed by the surf. This is a rather slow and tedious procedure, and the organisms never could be obtained in very large numbers. This problem, however, was solved when the Steinhart Aquarium in San Francisco introduced eggs of the brine shrimp, *Artemia.* These are obtained from an almost inexhaustible supply in the brine pits along the California coast. The eggs will hatch in ordinary standing seawater (slightly concentrated by heating or evaporation) within twelve to twenty-four hours. If a rich growth of algae is present continuously in the jars or trough in which they are hatched, the organisms will grow and metamorphose very rapidly to the adult stage (one to one and a half inches long). These adults have been kept for as long as three months, and in some of our experimental jars two and three generations were obtained from the original parent stock.

One of our most important exhibition fish, the Sea-horse, is entirely a plankton feeder. Heretofore, it has been very difficult to keep these alive during the summer and winter months, at which times they are very scarce. With this new source of food on hand we hope to retain many individuals on exhibition throughout the entire year. The pipefish, a close relative of the seahorse, is another fish that is difficult to keep alive because of this fact. On many occasions seahorses in the Aquarium have given birth to large numbers of individuals, but due to lack of available food we were unable to keep them alive. With a large supply of brine shrimp eggs on hand, we may be able to raise some of these to the adult stage.

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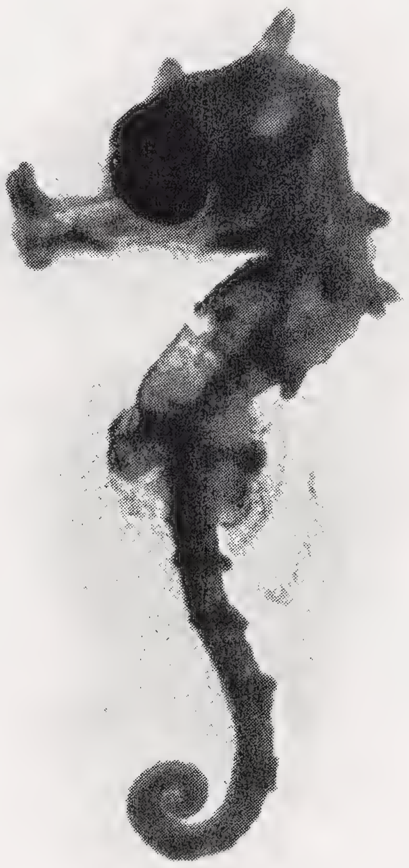
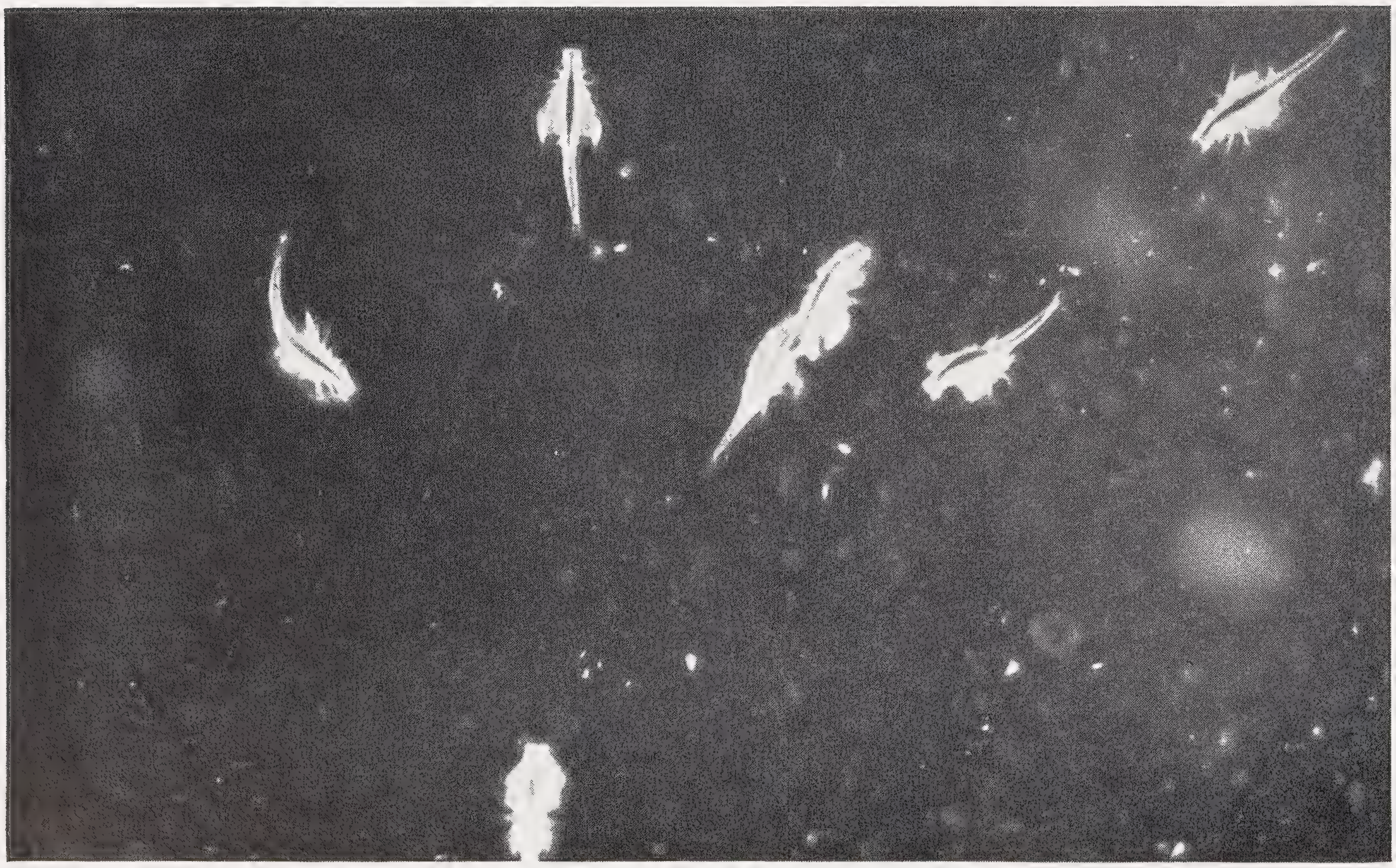
[1] Bond, R. M. (1934) Science, 70:60.





Upper: This specimen of the sea-horse is one of many born in the tanks of the Aquarium last year. Due to the lack of an abundant food supply (such as we have this year) they were kept alive for only a very short time. This individual measured about 4 mm., three days following birth. *Lower:* Fully grown individuals of *Artemia* which were hatched and reared in the Aquarium. These small crustaceans make suitable food for many of the small marine fishes.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-six volumes completed. Volume XXXVII in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
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Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
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Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
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Cultivation of Fishes (Townsend); 27 pp. 17 ills.
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Post-cards: General Exhibits. Sets (12) colored.
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For all Aquarium publications or any work relating to Aquatic Life, address the NEW YORK AQUARIUM, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. MITCHELL, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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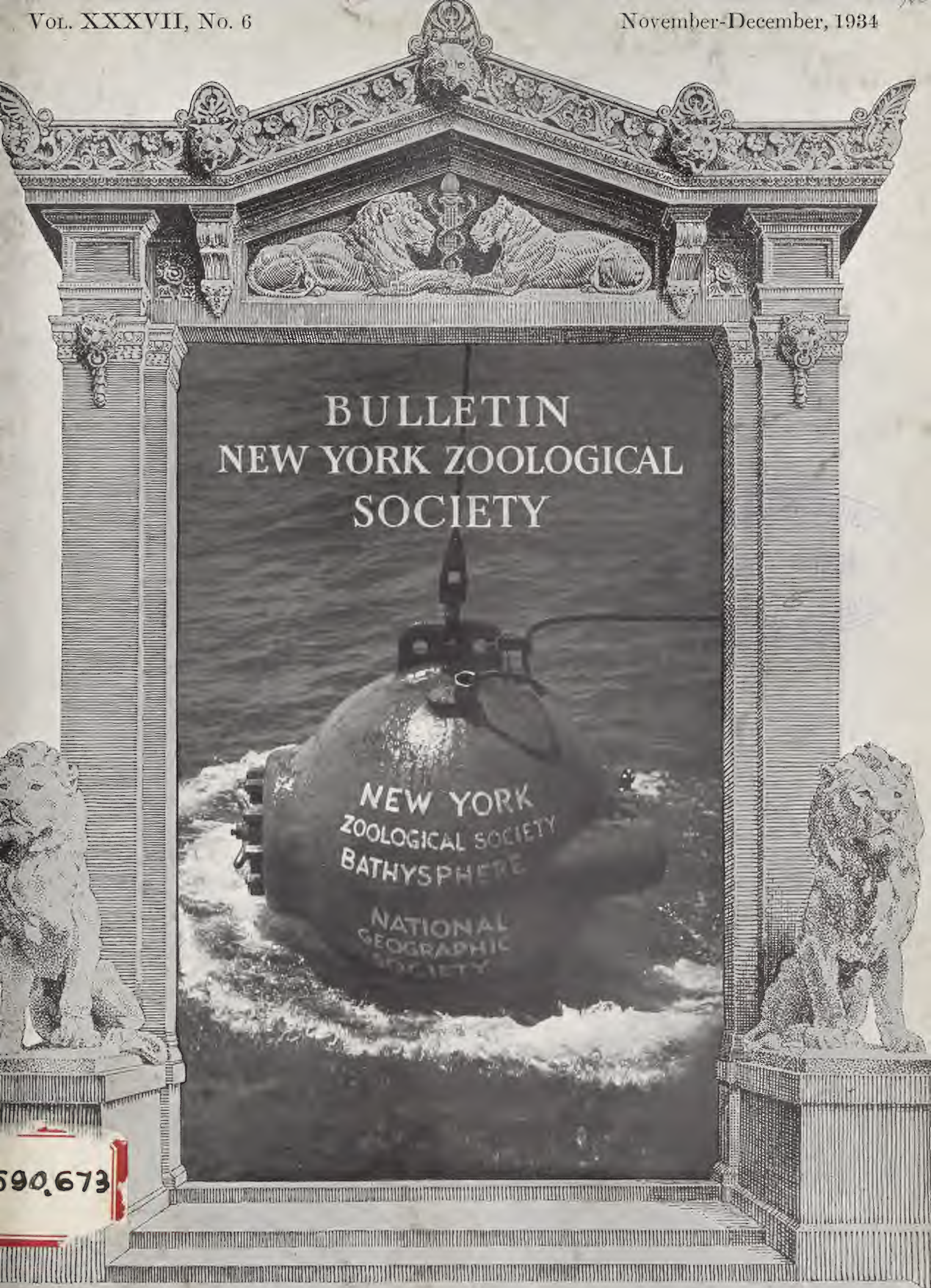

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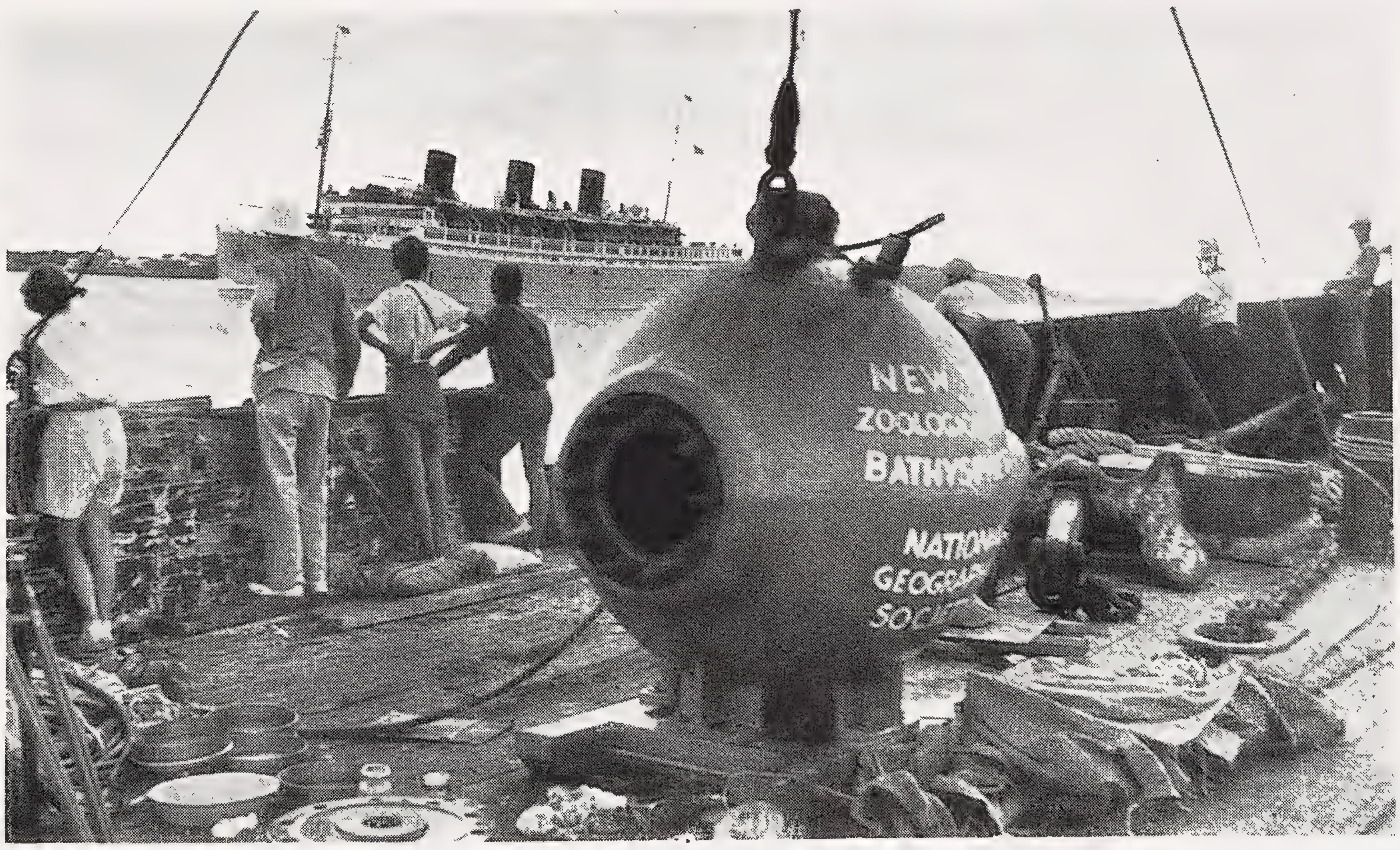

The *Queen of Bermuda* saluting the Zoological Society's *Ready*,
returning from a Bathysphere Dive of 2510 Feet.

BULLETIN

New York Zoological Society

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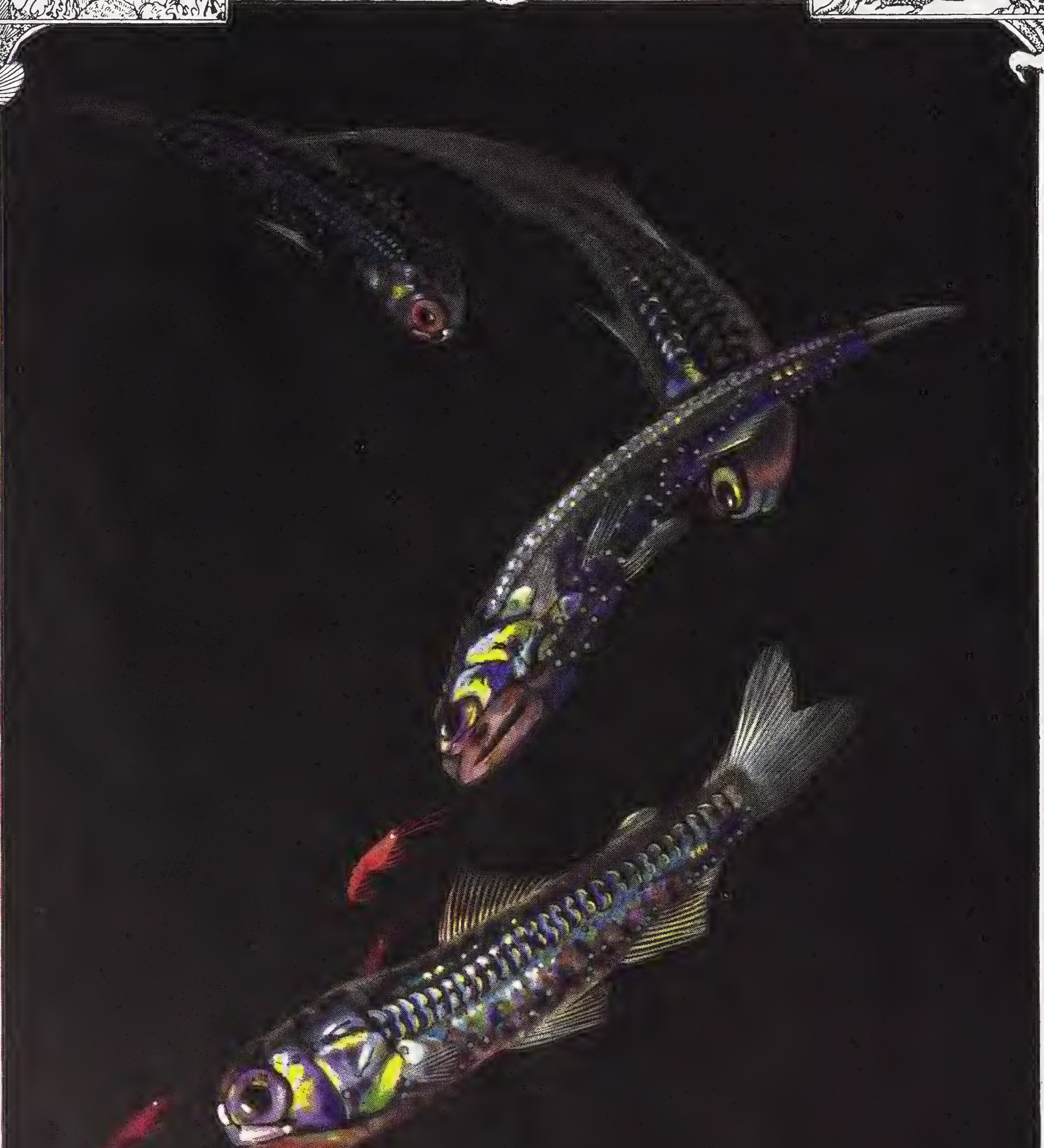


LANTERN FISH

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

Vol. XXXVII November-December, 1934 No. 6

Activities of the Department of Tropical Research

Season of 1934

William Beebe, *Director*

OUR department of the Zoological Society undertook two major achievements during the present year, and we have had the good fortune to accomplish both. The first was to remain at least three hours in the bathysphere and attain a depth of over half a mile, and the second was to obtain a motion picture record of the development of the giant, pelagic eel eggs which we obtain several miles off shore. Far more important than the actual diving record were the many observations on deep-sea creatures which we obtained, and of far more scientific value than the film record, were the notes which we accumulated on the development of the eggs and larvae.

I had planned in connection with this work, to experiment with vitamins and other substances, in an endeavor to keep the larvae of pelagic fish alive beyond the period of yolk absorption. This investigation was interrupted at an early stage by preparations for the deep dives, so that it will have to be postponed until another season.

Miss Crane, with Mr. Swanson's help as artist, so far advanced the systematic work on larval and adult deep-sea eels, that I will soon be able to carry it on for early completion and publication. As a change of work I had Miss Crane make a thorough quantitative analysis of the contents of a typical, six-net, deep-haul, which appears in this Bulletin.

Miss Hollister is well on with the Isospondyl tail studies, and her viability results with salt and fresh-water fish, outlined in the following pages, have brought out many interesting facts. Mr. Tee-Van has been responsible for all the mechanical details of the bathysphere, which have turned out so perfectly, and has taken as his own special problem the operation of the new stop motion picture camera. Mrs. Bostelmann completed the major number of sixteen colored plates for the National Geographic Magazine bathysphere article, besides dozens of other paintings. Mr. E. J. Geske of Florida has made several exquisite marine studies for our work.

There are ready for publication: the special bathysphere article in the National Geographic Magazine for December; the present Bulletin and a volume dealing with all the bathysphere dives, under the title "Half Mile Down." This is being published by Harcourt, Brace and Co., under the auspices of the Zoological Society.

The dives, both vertical and contour, are over for the present year, and the bathysphere has been brought back for exhibition at the American Museum of Natural History. Before we stopped operations in the field it seemed only right to let all the staff, after their strenuous, nerve-wracking work on deck, see something of the under-sea sights for themselves. As records seem to be considered so important in the public mind, I append a table of present record descents in the bathysphere;

3028 feet—Beebe and Barton
1533 " —John Tee-Van

1208 " —Gloria Hollister
1150 " —Jocelyn Crane
550 " —Perkins Bass and William Ramsey
525 " —The world's previous record descent for a living man.

Our laboratory at New Nonsuch answered every requirement. Never in the course of our twenty expeditions have we ever been so comfortable or worked with such facilities or among such delightful surroundings. Our fleet of five boats have all been in constant use, from the canoe and dinghy, to the *Monocle* or glass-bottomed boat, and the twenty-six foot launch, the *Skink,* the generous gift of William Delano five years ago, which has never ceased to function.

Our visitors have been numerous, totalling about two hundred for the six months. Thanks to hints to the hotel managers and carriage drivers, all casual tourists are driven past. Those who have come were inspired by real interest in our researches, and were more than welcome. A few among them were:

Mr. and Mrs. John M. Schiff, Mr. and Mrs. Childs Frick, Mr. and Mrs. John S. Gibbs, Jr., all of whom spent some time with us and who enjoyed diving with the helmet in six fathoms of water. Mr. and Mrs. M. B. Flynn, Mr. and Mrs. Herman Oelrichs, His Excellency the Governor and Lady Cubitt, Lord Carew, Mr. Grover Whalen, Mr. Roland Young, Dr. and Mrs. R. C. Bevens, Mr. and Mrs. Keats Speed, Mr. and Mrs. John Stratten, Miss Blanche Yurka, Mr. and Mrs. Hal Fletcher, Commander and Mrs. Morrison, Sir Stanley and Lady Spurling, and Colonel and Mrs. Thomas Dill and Vice-Admiral Sir Reginald and Lady Drax.

Tropical Research 1934 Staff at the Entrance of New Nonsuch, Bermuda. From left to right: Beebe, Crane, Tee-Van, Bass, Ramsey, Swanson, Bostelmann and Hollister.

Five Hundred Fathoms Down

William Beebe

On the 8th of February, 1934, Dr. Gilbert Grosvenor on behalf of the National Geographic Society offered to finance a season of deep dives in the bathysphere. This was generously in cooperation with the Zoological Society, with many equal advantages for both. This was agreed to by the Trustees of the Zoological Society and preparations were begun at once for the new expedition. The bathysphere, which is now the property of our Society, was recalled from the Century of Progress Exposition where it had been on exhibit for the past year, and was thoroughly overhauled at the factory where it had been built. The old windows were found to have deteriorated and the oxygen apparatus was considered inadequate for the new adventure. Generous friends came forward and helped in every way, as I have indicated in detail elsewhere in this Bulletin.

The Department of Tropical Research started for Bermuda on its Twentieth Expedition on April 28. The staff this year consisted of William Beebe, John Tee-Van, Gloria Hollister, Jocelyn Crane, Else Bostelmann, George Swanson, Perkins Bass and William Ramsey. Of the new members, Mr. Swanson was an artist whose work supplemented that of Mrs. Bostelmann's, while Bass and Ramsey, recent graduates of Dartmouth, volunteered as general assistants in the season's scientific work.

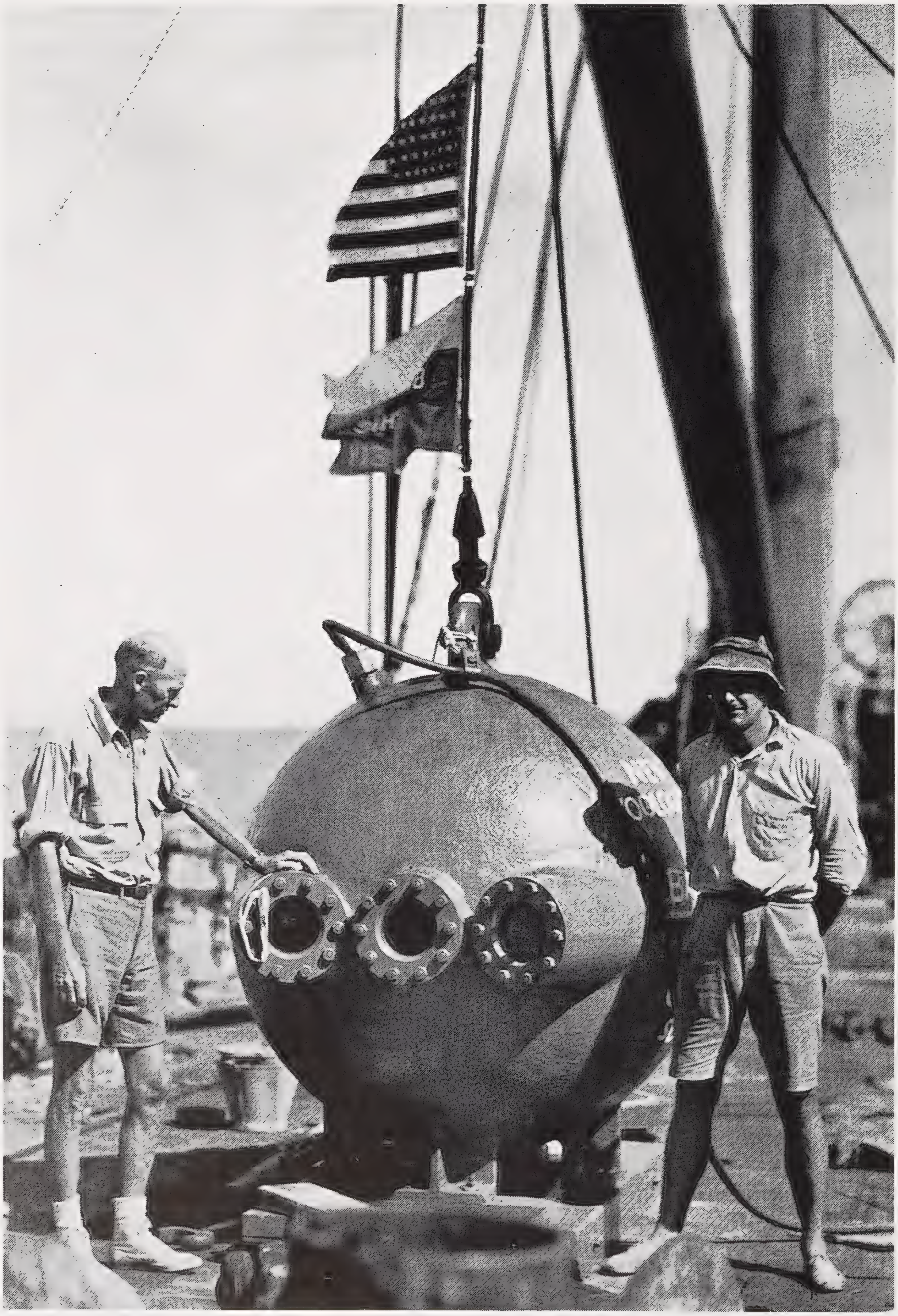
By the kindness of Dr. E. G. Conklin and the Trustees of the Bermuda Biological Station we were again permitted to board and mess at the Station. Seven minutes' walk to the east of this Station is our New Nonsuch Laboratory. This we occupied at once and used as our headquarters of operations. With its position on open water, and the boat-house and wharf completed, and its complete laboratory outfit, we found it an ideal place for work.

The outfitting for deep diving of the bathysphere was a slow and careful operation. The participants realized that in an investigation of this kind only a single error is necessary. If anything broke down, no parachute would be of any avail, and if the windows or door proved faulty, there could be no second attempt. At last we received word that everything was ready, and on July 5 the bathysphere arrived in Bermuda. I had cabled to Otis Barton in Panama to join me if he so desired. He accepted and asked that his part in the dives might be that of photographer.

There was further delay at the Bermuda end, for the tug *Gladisfen* had been laid up for two years and had to be overhauled, while the ancient barge *Ready* had suffered from the weather, and the installation of the winches and boilers entailed new piping and even parts of the deck itself.

On the 6th of August we were at last ready for the take off. Our slogan "Three Hours and a Full Half-Mile," had worked on the nerves of our grand, conservative Captain Jimmie Sylvester and he asked for a rehearsal while we were still at anchor. This proved to be a comic interlude, for we crawled inside, and John Tee-Van, knowing the bottom was only twenty-two feet down, screwed on only four out of ten door bolts, and sent us over. Four feet under, as I was watching a silvery host of fry sweeping back and forth, my feet and ankles suddenly felt chilly, and reaching down I found about a foot of water in the bottom of the sphere, and the door showed a healthy stream of water pouring in from three sides. We were lifted clear, and back on deck, opened up, dried out and again sealed up properly. The result of this dive was a joking matter, but valuable as showing how necessary it is never, for an instant, to relax precautions. The first fraction of a second after I discovered the in-pouring flood aroused a subconscious reaction all its own, which will never quite be eradicated by the instantly succeeding ones of reason and humor.

On August 7, I disregarded the prophecy of squalls and uncertain winds, and we put to sea, and sent the bathysphere down empty for a test dive, from which she returned dry and in perfect condition. After several days of bad weather, I again threw my dice against unsettled conditions, and on Saturday, August 11, at half past nine in the morning I looked about from the deck of the *Ready* and saw the long,



At the Upper End of the Half Mile Dive.
Photo by David Knudsen.

low swells of a calm day at sea. We were well within our magic circle, where all previous dives had been made, and where we had pulled more than fifteen hundred nets, from the surface to a depth of two miles. Nonsuch Island was six and a half miles to the north. Here we slowed down, headed upswell, and prepared to dive.

More than three and a half years ago we dived to a depth of 1426 feet, and here I was on the selfsame ancient barge, with the identical bathysphere, and within a mile and a half of the very spot where we made the former descent. An equal distance marked the spot of two years ago, when we touched 2200 feet.

On the present dive we went down to a depth of 2510 feet, and returned safely, with a maze of impressions of the life of a world, as new and as strange to me as if I had not twice visited it before. I was able not only to recognize many of the deep-sea fish I had caught during the past six years, but even to record and reproduce in words, and by proxy in paintings, many details of wholly new forms. Three of these I have described in this Bulletin.

In the never ceasing excitement of watching abounding life I had completely forgotten the idea of a half-mile record, and when on deck, three hours and ten minutes after we had been sealed up, we were reminded that an additional hundred and thirty feet would have done the trick. I had no regrets. A man-made unit of measure is of far less importance than my Three-starred Angler which otherwise we should surely have missed.

Late in the afternoon, as we reached the entrance of St. George harbor, the mighty *Queen* of the Furness Line passed close to us, and Captain Davis, seeing the 2510 chalked on our bow, roared out a salute of congratulations.

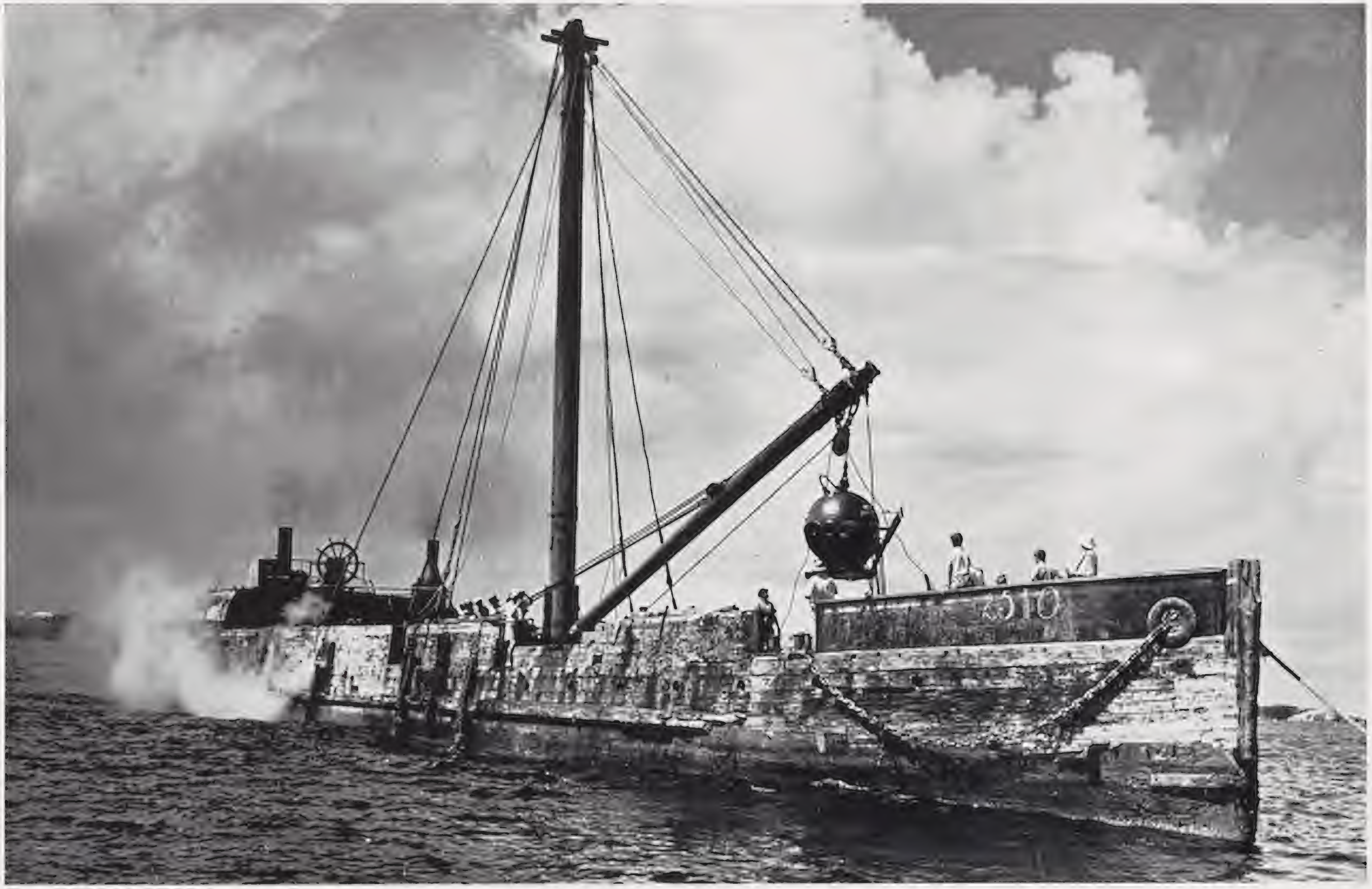
The following day, Sunday, we devoted to translating and augmenting our notes with added remembered details, and getting everything ready for the next dive. Believing that the best kind of rest is a change of activity, on Monday, August 14, we took the *Skink,* our launch, and went ten miles out from shore to North Rock, the last forlorn hope of Bermuda's dry land, still standing far out against the eternal beating of the open sea. Diving in the helmet in seven fathoms at the edge of a magnificent reef, I had the amazing luck of seeing all the so-called dangerous fishes of Bermuda, sharks, barracudas, and green moray eels, within a half hour and a space of twenty square feet.

All, as usual, were harmless, and only when a five-foot shark stoutly contested the possession of a rare puffer which I had just stunned with a dynamite cap, was I compelled to bang it on the snout and drive it away. To an onlooker from above, as in this case Mr. John Long of the National Geographic staff, it appeared to be material for full-sized headlines; from down below, the fact that the shark was only another fish was true simply because experience had taught us its harmlessness. On the final dive five sharks were gathered and interested in everything I did, but only as vultures are drawn at the sound of a hunter's gun, by the hope of a feast.

The following day we went to sea in the *Gladisfen* and drew deep-sea nets across the very place I had dived in the bathysphere so few hours before. As always, we were delighted with the sight and touch of beings from the icy depths, and at the same time amazed at the meagreness of the haul compared with what I knew of the abundance of life through which the nets had passed. However, each net was filled with interesting creatures, some of which were still to be named. Best of all, instant transference into iced salt water revived many of them.

Here again, John Tee-Van was in charge of the deck machinery, with Bass and Ramsey as aides. I was winchman except at the actual incoming of the nets, when Miss Crane and I watched and took notes of the movements and colors of the living and just dead catch. A pair of ten-inch Scimiter-Mouths, such as I had seen on the last dive at a depth of four hundred fathoms, were alive, and for the first time we had a Black Swallower, *Chiasmodon niger,* swimming full speed about his jar. Unlike most of his kind, his stomach was empty and not distended with one of his unbelievably enormous meals. Another treasure was a living, gay-colored, semi-transparent, telescope-eyed *Dolichopteryx,* the Long-finned Ghostfish, probably a new species. It was the sixteenth of the whole genus to be taken by man, and the first ever to be seen alive.

Day after day my weather held good, and Wednesday, August 15, as I have written in



The Barge *Ready* returning from the Bathysphere dive of 2510 Feet.
Photo by David Knudsen.

Final Consultation before the Half Mile Dive.
Photo by David Knudsen.

the National Geographic Magazine, was no exception. At 6:45 in early morning we were arranging to leave St. George's anchorage, the barge *Ready* with the bathysphere and ourselves, and the tug *Gladisfen* towing. Three hours later, Mr. Barton and I were dropped overboard far out at sea. As well as we could determine from sights on the two lighthouses, we submerged at the identical spot into which we had splashed four days before.

The same spot, but far from the same visible life. Surprises came at every few feet and again the mass of life was totally unexpected, the sum total of creatures seen, unbelievable. Although I delayed very little at the hundred-foot stops, when the guy ropes were attached, yet I dictated page after page of observations. I used the light as little as possible and carefully shielded my eyes, so that very soon they became dark-adapted. I was watching for two or three things which I wanted to solve. Large Melanostomiatid dragon-fish with their glowing port-hole lights showed themselves now and then, and more than at other times, in our electric light, we had frequent glimpses of small opalescent copepods, appropriately called *Sapphirina,* which renewed for us all the spectrum of the sunlight.

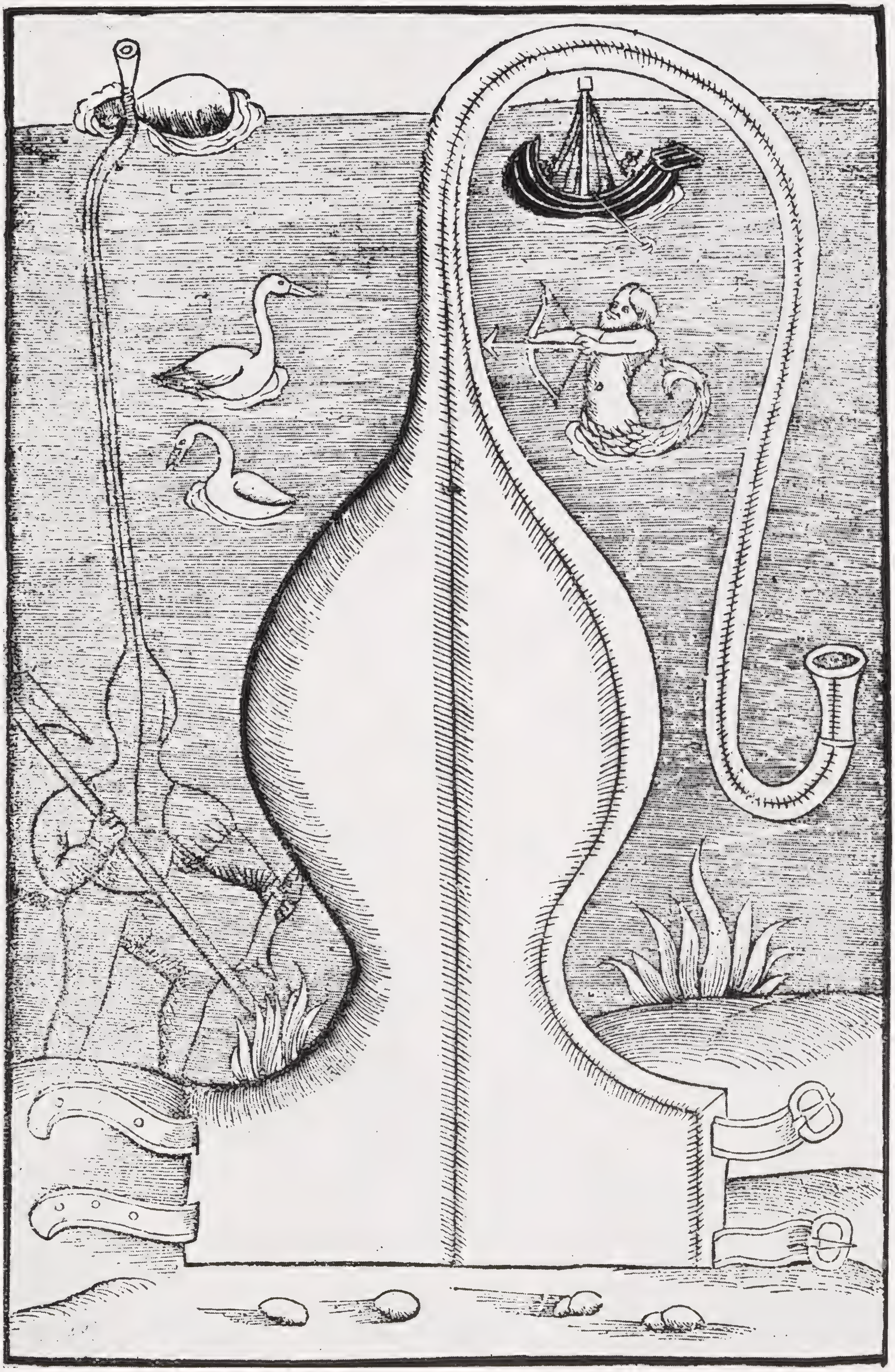
I consider the three outstanding moments of a bathysphere diver to be, the first flash of animal light, the level of eternal darkness, and the discovery and description of a new form of fish. There is a fourth—lacking definite level or anticipation, a roving moment which might very possibly occur near the surface or at the greatest depth, or even as one lies awake, long after the dive, thinking over and reliving it. It is, to my mind, the most important of all, far more than the new species. It is the explanation of some mysterious occurrence, the solution of some remarkable habit, which has taken place before our eyes, but which, like the sublimated trick of some master fakir, has, so far, evaded understanding.

This came to me on this last dive at sixteen hundred and eighty feet, and it explained much that had been a complete puzzle. I saw some creature, several inches long, dart toward the window, turn sideways and—explode. This time my eyes were focused and my mind ready, and at the flash, which was so strong that it illumined my face and the inner sill of the window, I saw the great red shrimp and the outpouring fluid of flame. This was a real Fourth Moment, for many "dim, gray fish" as I have reported them, now resolved into distant clouds of light, and all the previous "explosions" against the glass became intelligible. At the next occurrence the shrimp showed plainly before and during the phenomenon, illustrating the value in observation of knowing what to look for. The fact that a number of deep-sea shrimps have this power of defense is well known, and I have had a glass aglow with the emanation. It is the abyssal complement of the sepia smoke-screen of a squid at the surface.

Before this dive was completed, I had made a still greater refinement in discernment, perceiving that there were two very distinct types of defense clouds emitted, one which instantly diffused into a glowing mist or cloud, and the other which exploded in a burst of individual sparks, for all the world like a diminutive Roman candle. Both occurred at the window or near it a number of times, but it was the latter which was the more startling.

Another advance in bathyspheric educational technique was unconscious and was only accidentally brought to conscious realization. On a succeeding dive, I went down fifteen hundred feet and took Mr. Tee-Van, and he wondered at my ability to identify organisms which to him, on the first part of this descent into the dark zone, were only individual lights. As we compared notes I realized that I had learned instinctively to ignore the light as soon as possible and look to left or right of it. Exactly as the spiral nebula in Andromeda can be seen most clearly by looking a little to one side, so the sudden flashing out of a light is less blinding when viewed indirectly, and simultaneously its author may more than likely come into focus. Before we returned to the surface Tee-Van had followed this method and saw eye to eye with me in subsequent identifications.

At eighteen hundred, I saw a small fish with illuminated teeth lighted from below, with distinct black interspaces; and ten feet below this my favorite sea-dragons, *Lamprotoxus,* appeared, they of the shining green bow. Only sixteen of these fish have ever been taken, seven of which came up in our own nets. The record size is about eight inches, while here before me were four individuals all more than twice that length, and very probably representing new spe-



One of the First Published Designs for a Diving Helmet.
From Vegetius, 1553.

Breaking Through the Surface at the End of the Deep Dive.

cies. The green side glowed, but the long chin tentacle was quite invisible, certainly giving out no light. At twenty-one hundred feet two large fish, quite three feet over all, lighted up and then became one with the darkness about them, a tantalizing glimpse which made me, more than ever, long for bigger and better nets.

At twenty-four fifty a very large, dim, but not indistinct outline came into view for the fraction of a second, and at twenty-five hundred a delicately illuminated ctenophore jelly throbbed past. Without warning, the large creature returned and this time I saw its entire length as it passed through the farthest end of the beam. Twenty feet is the least possible estimate I can give to its full length, and it was deep in proportion. The whole creature was monochrome, and I could not see even an eye or a fin. For the majority of the size-conscious human race this *"Marine Monster"* would, I suppose, be the supreme sight of the expedition. In shape it was deep oval, it swam without effort, and it did not return. This is all I can contribute, and while its unusual size so interested me that for several hundred feet I kept keenly on the lookout for hints of the same or another large being, I soon forgot it in the (very literal) light of smaller, but more distinct organisms.

What this great creature was I cannot say. A first, and most reasonable guess, would be a small whale or blackfish. We know that whales have a special chemical reaction in their blood which makes it possible for them to dive a mile or more, and come up without getting the "bends." So this paltry depth of twenty-four hundred and fifty feet would be nothing for any similarly equipped cetacean. Or, less likely, it may have been a whale shark, which is known to reach a length of forty feet. Whatever it was, it appeared and vanished so unexpectedly and showed so dimly that it was quite unidentifiable except as a large, living creature. It surely shows what still remains for the pioneer explorer of the depths of the sea.

Anyone, who from an airplane high above the earth, has tried to spot another plane somewhere near, in full view, will appreciate the even greater difficulty of focusing in this three-dimensional, stygian blackness, upon some creature, small or large, suddenly appearing six inches from our faces, or forty-five feet away. Again and again before the eye can refocus, the flash and its owner have vanished.

Mr. Barton saw no trace of the large creature I have mentioned, although I called out to him and got him at the window immediately. Soon after, when we were both looking out, he saw the first living *Stylophthalmus* ever seen by man, which completely escaped my vision, although it must have been within a foot of the window. My missing this fish was all the more disappointing because I had recently thoroughly studied these strange beings, and in fact had abolished their entire family, after proving that they were the larvae of the Gleaming-tailed Sea-Dragon, *Idiacanthus.*[1]

The next fish of unusual size was seen at twenty-nine hundred feet. It was considerably less than three feet, rather slender, with many, elongate luminous spots on the body, and a relatively large, pale-green, crescent-shaped light under the eye. Near it were five lanternfish, unlike all others I had seen. They swam so slowly that I was able to make certain, before they disappeared, that they were of the genus *Lampadena.*

At 11:12 A. M. we came to rest gently at three thousand feet, and I knew this was my ultimate floor. The cable on the winch was very near its end. A few days ago the water had appeared blacker at twenty-five hundred feet than could be imagined, yet now this same imagination worked to show it as blacker than black. It seemed as if all future nights in the upper world must be considered only relative degrees of twilight. I could never again use the word *black* with any conviction.

I looked out and watched an occasional passing light and for the first time I realized how completely lacking was the so-called phosphorescence with which we are familiar at the surface. There, whenever an ordinary fish passes, it becomes luminous by reflection from the lights of the myriads of minute animals and plants floating in the water. Here each light is an individual thing to our gross vision, often under direct control of the owner. A gigantic fish could tear past the window, and if unillumined might never be seen.

My eyes became so dark-adapted at these depths that there was no possibility of error;

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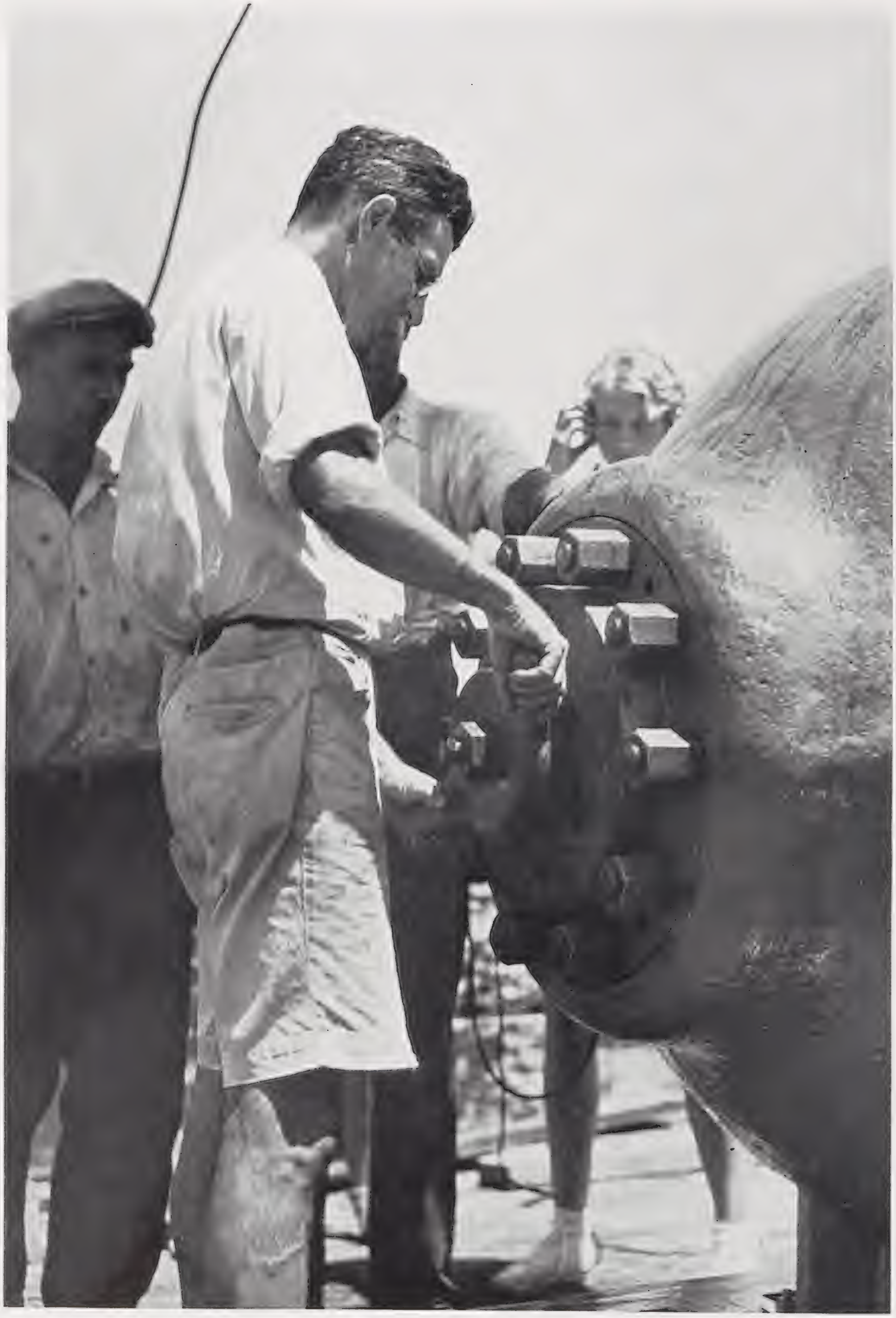
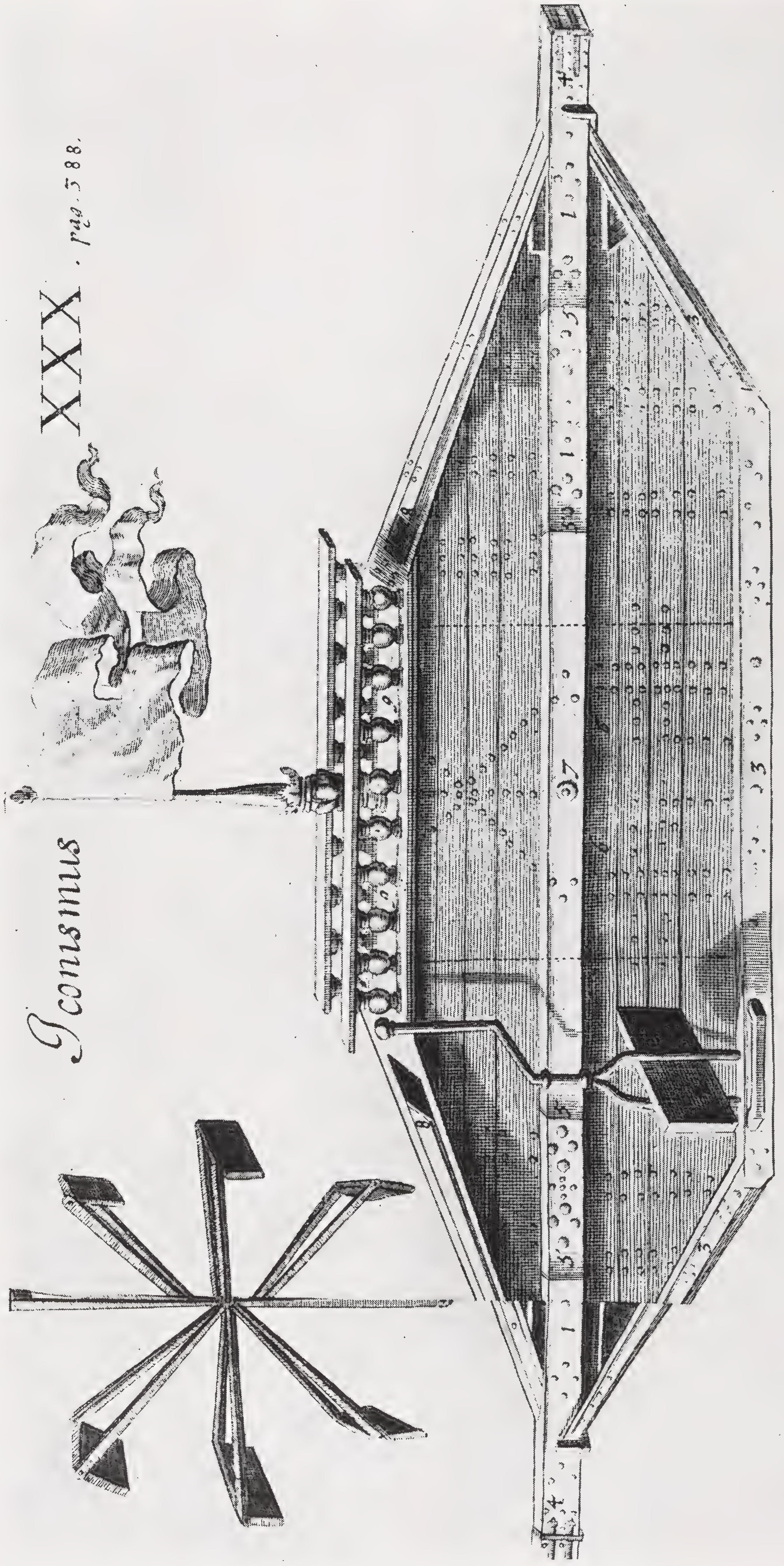
[1] Bull. Zool. Soc., Vol. 37, No. 3.



Slowly Unscrewing the Central Wing-bolt to Equalize the Air Pressure after Three Hours of Sealing. Photo by David Knudsen.

Into the Sunlight and Air again after a Three-Hour Dive.
Photo by David Knudsen.


Iconismus XXX. pag. 388.

The Rotterdam Ship: One of the first submarines ever designed. Seventeenth century.
Courtesy of the New York Public Library.

the jet blackness of the water was broken only by sparks and flashes and steadily glowing lamps, all of appreciable diameter, varied in color and of infinite variety as regards size and juxtaposition. But they were never dimmed or seen through or beyond any lesser mist or milky-way of organisms. The occasional, evanescent defense-clouds of shrimps stood out all the more strongly as unusual phenomena, and quite apart from the present theme. If the surface light is emitted chiefly by single-celled plants, the explanation of its abyssal absence is easy, for all plant life of the sea has died out hundreds of feet overhead.

A second thing which occurred to me as I sat coiled in the bathysphere, more than half a mile down, was the failure of our powerful beam of light to attract organisms of any kind. Some fled at its appearance, most seemed wholly unconcerned, but not a single copepod or worm or fish gathered along its length or collected against the starboard window from which it poured. We sometimes kept the lesser beam on for three minutes, so there was abundance of time for the plankton, which abounded in all parts of the path of light, to feel and react to its influence. The reason for this demands far more observation than several dives can give. One factor, doubtless, is not only the lack of all rhythm of day and night, but the eternal absence of all except animal light.

Now and then, when lights were thickest and the watery space before me seemed filled with life, my eyes peered into the distance beyond all I could see, and I thought of the lightless creatures forever invisible to me, those with eyes which depended for guidance through life upon the glow from the lamps of other organisms, and, strangest of all, those inhabitants of the deeper parts of the ocean, blind from birth to death, whose sole assistance to food, to mates, and to escape from enemies, were cunning sense organs in the skin, or on long, tendril-like fin-rays.

Even in this extremity of blackness I sensed the purity of the water, its freedom from sediment and roiling; six miles from shore and a full mile from the bottom insured this. So there was no diffusion of light, no luminous trails, no refraction. When sparks or larger lights moved, they were as distinct as when they were motionless. But reflection was noticeable, as upon the eye or skin from a subocular or a lateral photophore, or upon my face when a shrimp exploded close in front.

* * *

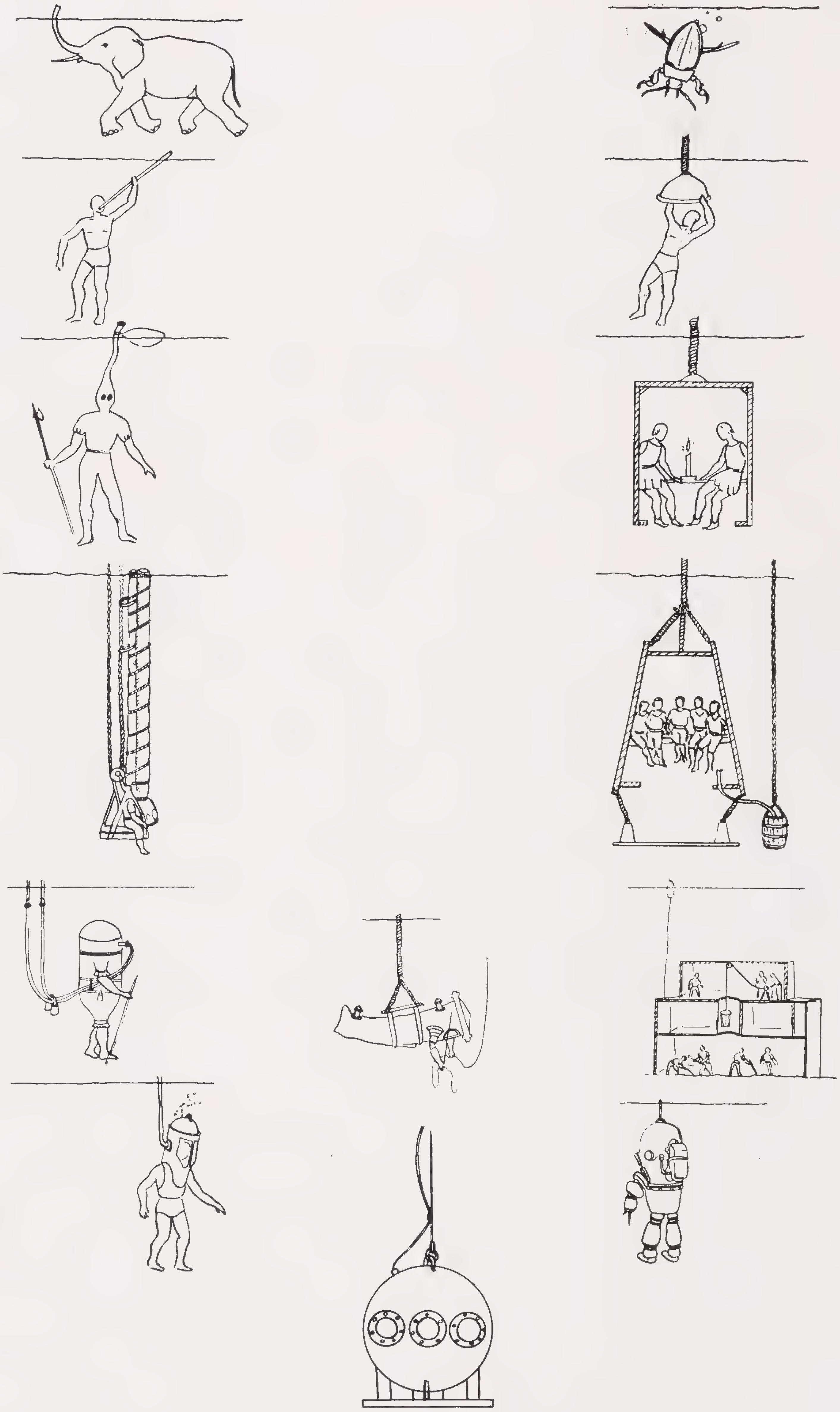
Now and then I felt a slight vibration and an apparent slacking off of the cable. Word came that a cross swell had arisen and when the full weight of bathysphere and cable came upon the winch, Captain Sylvester let out a few inches to ease the strain. There were only about a dozen turns of cable left upon the reel, and a full half of the drum showed its naked, wooden core. We were swinging at three thousand and twenty-eight feet, and, would we come up? We would.

Whatever I may think about the relative value of intensive observation as compared with record breaking, I had to admit that this ultimate depth which we had attained, showed a decided increase in the number of large fish, more than a dozen having been seen. There was also a corresponding greater number of lights, though not in actual size of their diameters.

Before we began to ascend, I had to stop making notes of my own, so numb were my fingers from the cold steel of the window sill, and when I shifted from my cushion to the metal floor, it was like sitting on a cake of ice. As to pressure, there seemed no reason why we should not be outside in a diving helmet, as well as in. I thought of a gondola sixty thousand feet up in the stratosphere with a pressure of one pound to the square inch. And then through the telephone we learned that at this moment we were under a pressure of thirteen hundred and sixty pounds to each square inch, or well over half a ton. Each window held back over nineteen tons of water, while a total of seven thousand and sixteen tons were piled up in all directions upon the bathysphere itself.

Yes, we had heard clearly, we were ready to be pulled up at once, thank you.

At twenty-nine hundred and twenty-nine feet I heard a metallic twang through the telephone, and asked what it was. I got some non-committal answer. I found out later that one of the guy ropes used in spooling the incoming cable on the drum had suddenly given way with a terrific report, a ghastly shock to everyone on deck until they realized it was a rope and not the cable. Truly, we in the bathysphere had the best of it at all times!

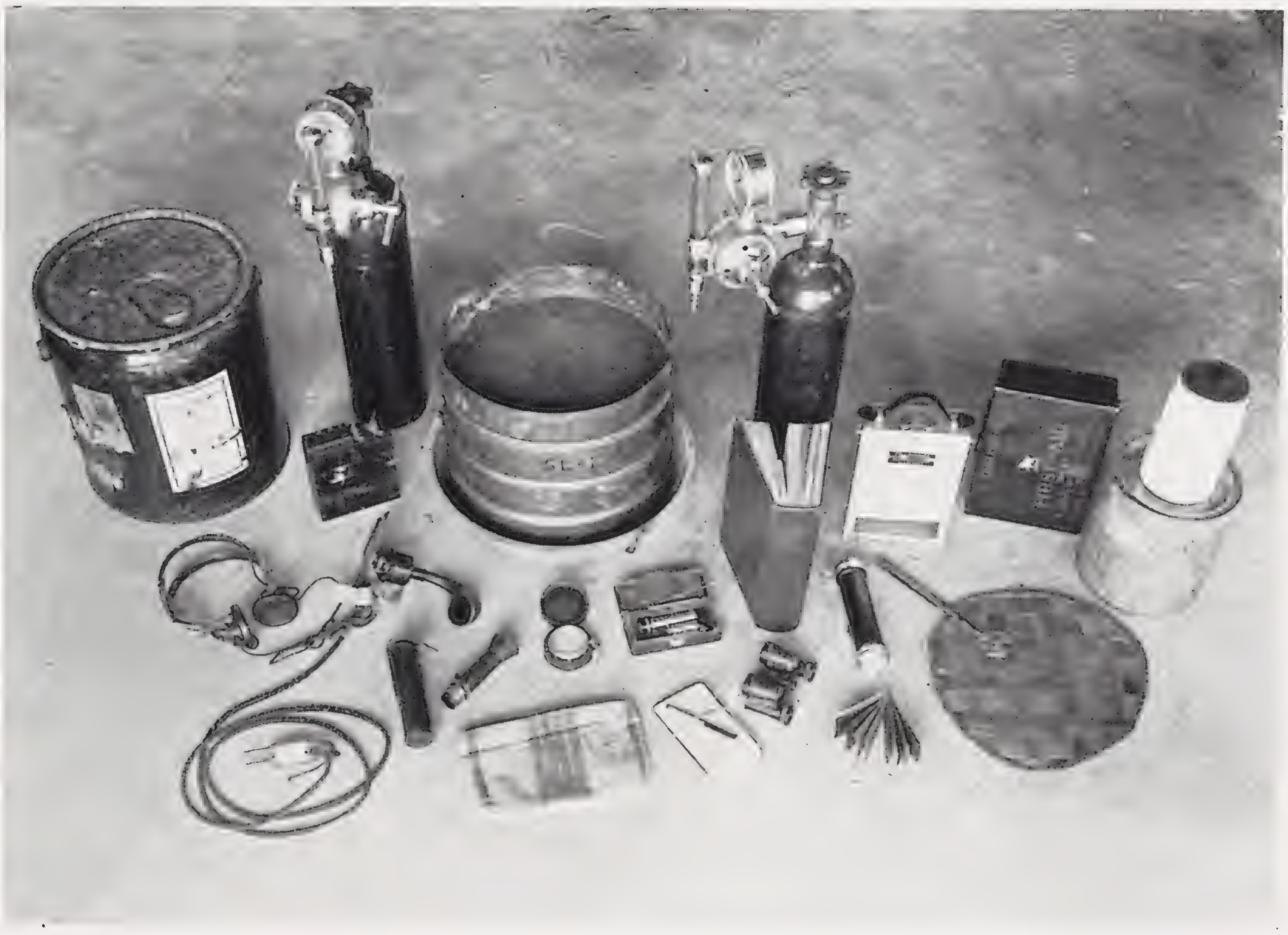


The Evolution of Human Diving. The left column shows the various attempts at drawing air down from above to the diver, from the elephant's trunk to the modern helmet and hose. The right column illustrates the gradual attainment of success in actually conveying a supply of air beneath the surface. The water beetle does this, and points the way, from the inverted vase of Aristotle to the self-contained bathysphere.
Drawing by George Swanson.

The Bathysphere of 1934

JOHN TEE-VAN

IN the year 2034, the Zoological Society's bathysphere will be looked upon as we now gaze at Stevenson's "Rocket," for our descendants will be acquainted with super bathyspheres; spheres resembling ours even less than the modern giant locomotive resembles its famous prototype, and capable of descending to the deepest bottom of the ocean.



Instruments and Tools Used in the Bathysphere. Photo by John Tee-Van.

In the four years of its life, a number of alterations have been made in the bathysphere and its operation.* These are of interest as being the first steps in the advance toward the bathysphere of the future.

Externally the sphere is the same as when built, although new quartz windows and window frames have been installed, the former because of partial failure of the old windows and their subsequent cracking during removal, and the latter for additional strength. The old copper washers of the doorway, because of the tremendous pressures exerted upon them, had crystallized, lost their resiliency, and had to be replaced.

Internally the bathysphere is approaching the dream of what Martian machinery ought to be like. The illustration on page 172 shows the present distribution of the apparatus; an arrangement quite unlike that of 1930 and 1932. Although apparently complicated, in reality it is very simple, and can be divided into machinery for purifying the air, for producing light and for transmitting speech.

In the figure the left hand apparatus is the chemical blower. This consists of a small electric fan on top of a cone that connects with four tightly-fitting, brass, wire-bottomed trays. When in operation the air of the bathysphere is sucked in by the fan and forced through the chemicals in the trays,—soda-lime in the upper two and calcium chloride in the lower pair, and thence back into circulation, the soda-lime having retained the carbon dioxide breathed out by the divers and the calcium chloride the moisture. The blower passes the entire air of the bathysphere over the chemicals about once in ninety seconds.

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* The bathysphere and its early operation is described in the Bulletin of the New York Zoological Society, Vol. XXXIII, No. 6, November-December, 1930.

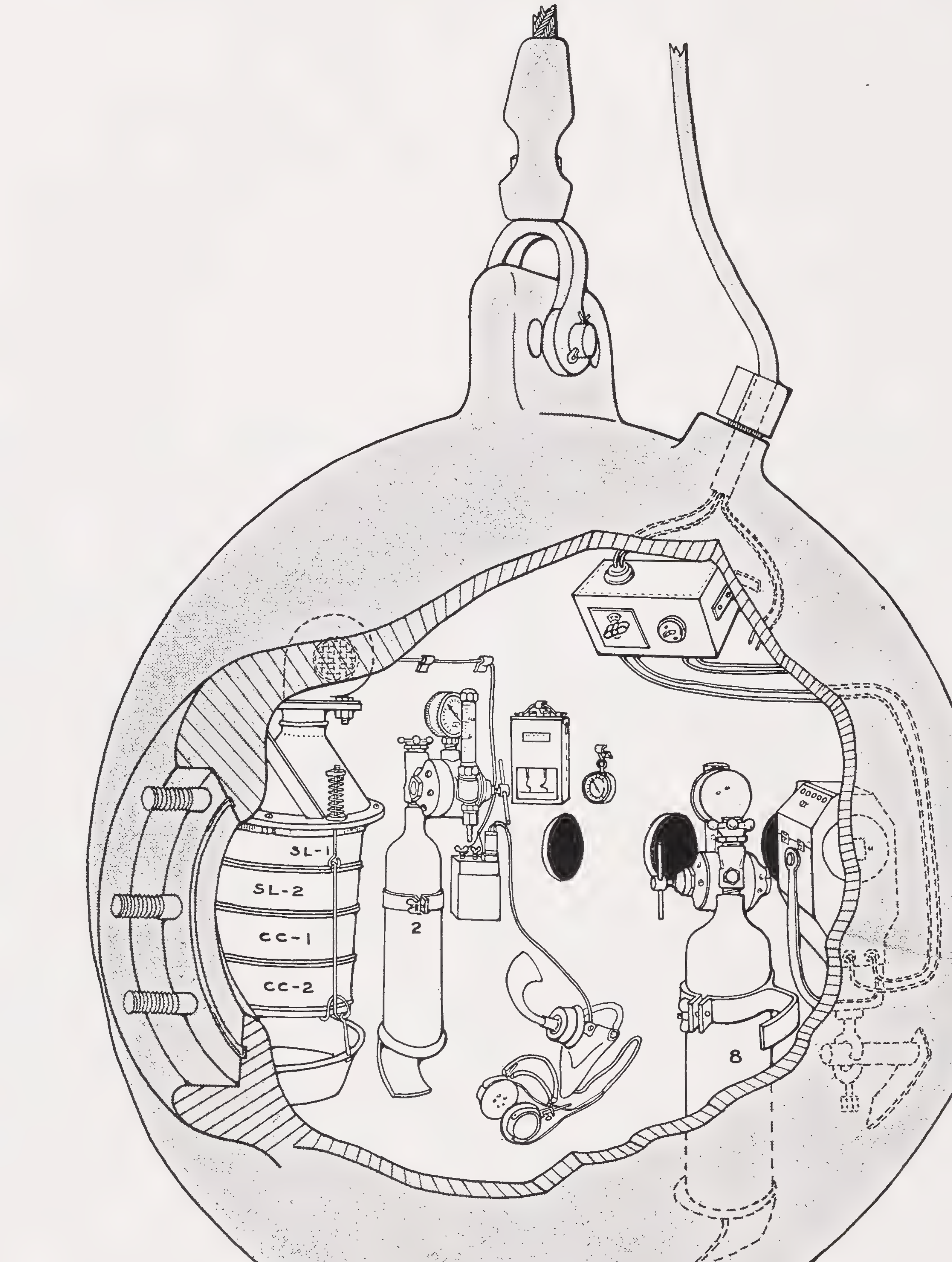


Diagram of the Bathysphere of 1934. Above; clevis for attaching supporting cable to sphere; above to right, communication cable entering sphere through stuffing-box, two of its wires passing to the telephone box, and two to the switch box that distributes power to the searchlight and the chemical blower. Middle section of bathysphere, from left to right, chemical blower apparatus, oxygen tank and valve, telephone box and instruments, temperature-humidity recorder, barometer, emergency oxygen tank and valve, and searchlight. Drawing by John Tee-Van.

Next to the chemical blower is an oxygen tank and valve like those on the opposite side of the sphere. The tanks are similar to those used before, each containing about 80 gallons of oxygen, but the valves are of a totally new design. These insure, first, accuracy of oxygen discharge, correct to within one half of one per cent. of the gauge reading, and secondly, ability to discharge accurately against external pressure. Neither of these factors was attained in the single valve used in previous years.

Two other instruments, to the right of the left hand oxygen tank, are of use in checking the atmosphere; a recording thermometer and humidostat and a barometer. Temperature in the sphere is not controllable, except as the bathysphere descends into colder water. The percentage of humidity can be lowered by increasing the amount of calcium chloride and by running the blower at greater speed.

The small circular device next to the thermometer is a barometer whose only use is to indicate too great a flow of oxygen.

With the blower purifying the air many times more often than necessary and with oxygen supplied at a rate slightly greater than necessary, the bathysphere this year has an atmosphere that is slightly more oxygenated than ordinary air, a temperature of 68 to 85 degrees, humidity of 48 to 76 per cent, and carbon dioxide practically absent. This approaches our idea of the modern air-conditioned room.

The light-producing section of the bathysphere consists of a single searchlight controlled by the large switch of the switch-box. The bulb is of 1500 watt 110 volt capacity. Under usual circumstances the voltage in the sphere is about 72 to 76 volts, this reduction in voltage causing the lamp to produce about one-quarter its normal amount of light. This, however, was more than enough for visual purposes and the reduced light was especially advantageous as it generated very little heat. To run the lamp at full power, a shift from one generator to another at the surface resulted in 110 volts or more and full light capacity in the sphere.

The switch-box mentioned above (upper part of figure) is so arranged that the electric wires as they come from above are divided so that the current is distributed through separate switches to the searchlight and to the motor of the chemical blower.

The sound-transmitting part of the sphere consists of a set of telephone instruments that plug into a small box containing battery and coil. This box is then connected by wires that pass around the upper rear part of the sphere to the two telephone wires in the communication hose. On deck two telephones are available. The telephones used this year are the latest type adopted by transoceanic telephone operators. Conversation through them is infinitely easier than over the average instrument.

The communication cable through which the telephone and electric wires run was lengthened this year to a total length of 3,600 feet.

On deck the electrical equipment, exclusive of telephones, consists of two generators; an automatic 110-volt generator supplying most of the current, and an auxiliary one of higher and controllable voltage that was used when required for photography.

Close to the generators and part of the electrical circuit is the emergency signalling apparatus. This is a small box with suitable switches and lamps so arranged that in case of failure of the telephones, the lamp above can be thrown into the circuit with the searchlight in the sphere. Signalling can then be effected by blinking the lights on and off.

Beyond replacing all bolts and fastenings for holding the winches and pulleys to the deck, no changes have been made in the deck machinery, except for installing a small winch to pull the boom from side to side.

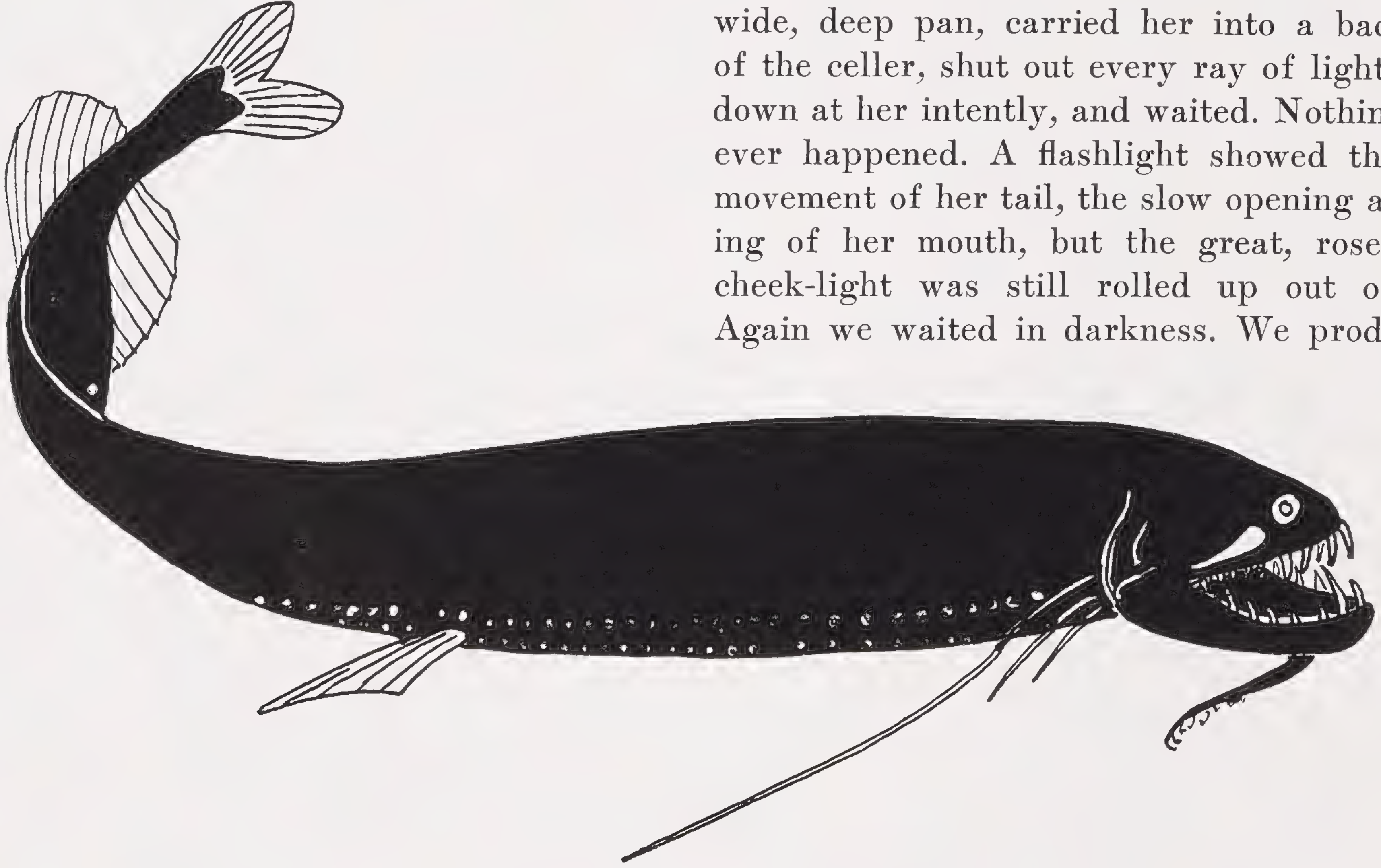
Lastly a change to simplicity has been made in fastening the electric hose to the main cable. In 1930 this was done with double-jawed brass clamps,—one jaw holding the cable, the other the hose. In place of these a six foot length of rope is now used, fastened to each cable at its ends by a clove hitch. This method has a number of advantages,—it is easier and more rapid to fasten the two cables together in this way; in case of a twist in the main cable the rope takes up the twist and not the communication cable; and lastly, in an emergency the ropes can be slashed by a knife and the bathysphere brought to the surface without stopping.

Thus, in the bathysphere of today, we can show progress in terms of simplification, making more certain the performance of the machinery necessary for the preservation of the lives of those who go down into the sea in bathyspheres.

Deep-sea Creatures of Six Net Hauls

JOCELYN CRANE

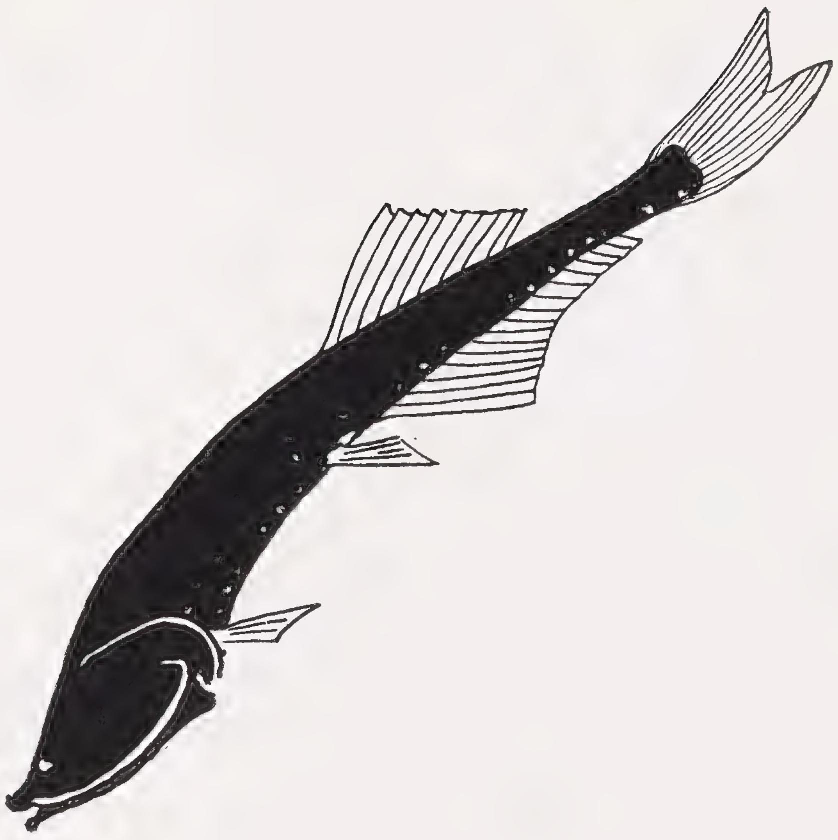
WE crowded around the long table with that special sort of feeling that belongs to Christmas morning. Outside was July, and Bermuda, and the warm radiance of a sunny five o'clock. But for us, that was all a pallid other-world. We were conscious only of those shining things of black and scarlet that spilled into the whiteness of the pans. New shapes; strange, fast-fading tints; weird creatures never seen alive before—no wonder that we pushed and peered and worried over slipping minutes. The first haul of the year was up from the depths of the ocean.



After our first brief survey for special treasures, we saw that an unusual number of animals were still alive. On the tug we had sunk each jar, as it was unfastened from the long, silk net, in a tub of cracked ice. Now, emptied out into the pans, the water was cold as its source a half mile and more below the surface, and many small shrimp-like forms were still tearing madly around in the water or feebly kicking at the bottom. These we carefully transferred to small dishes and placed in the refrigerator, for we had found that a familiar temperature was of much more importance in prolonging their lives than the most efficient pressure tanks.

When all possible first-aid rescues had been made and the study of the rest of the catch was well under way, we turned our attention to the prize of the haul, a foot-long, Rose-lighted Dragonfish (*Echiostoma*) from five hundred fathoms. She—we knew it was a she-dragon from her great size—was still waving her fins in her pail of ice-water. We poured her into a wide, deep pan, carried her into a back room of the celler, shut out every ray of light, stared down at her intently, and waited. Nothing whatever happened. A flashlight showed the slight movement of her tail, the slow opening and closing of her mouth, but the great, rose-colored cheek-light was still rolled up out of sight. Again we waited in darkness. We prodded her gently with a pencil. Suddenly she gave a mighty flip and her light winked out, illuminating fish, pan, and our excited fingers. Twice more the flash blazed up, and a pale glow showed the rows of body lights. Then one more magnificent display, and every movement stopped.

Feeling for a moment as though I had myself been half a mile down, I brought her out into the laboratory and carefully straightened her cold, soft, satiny blackness. It was only then, I think, that I realized the creature was a fish. Because they are so hard to catch, so delicate, and so very literally expensive, we treat our specimens with a kind of Hindoo reverence. Most would be irreparably damaged if we handled them with our fingers; instead, the finest of forceps, lifters and needles are used. Con-



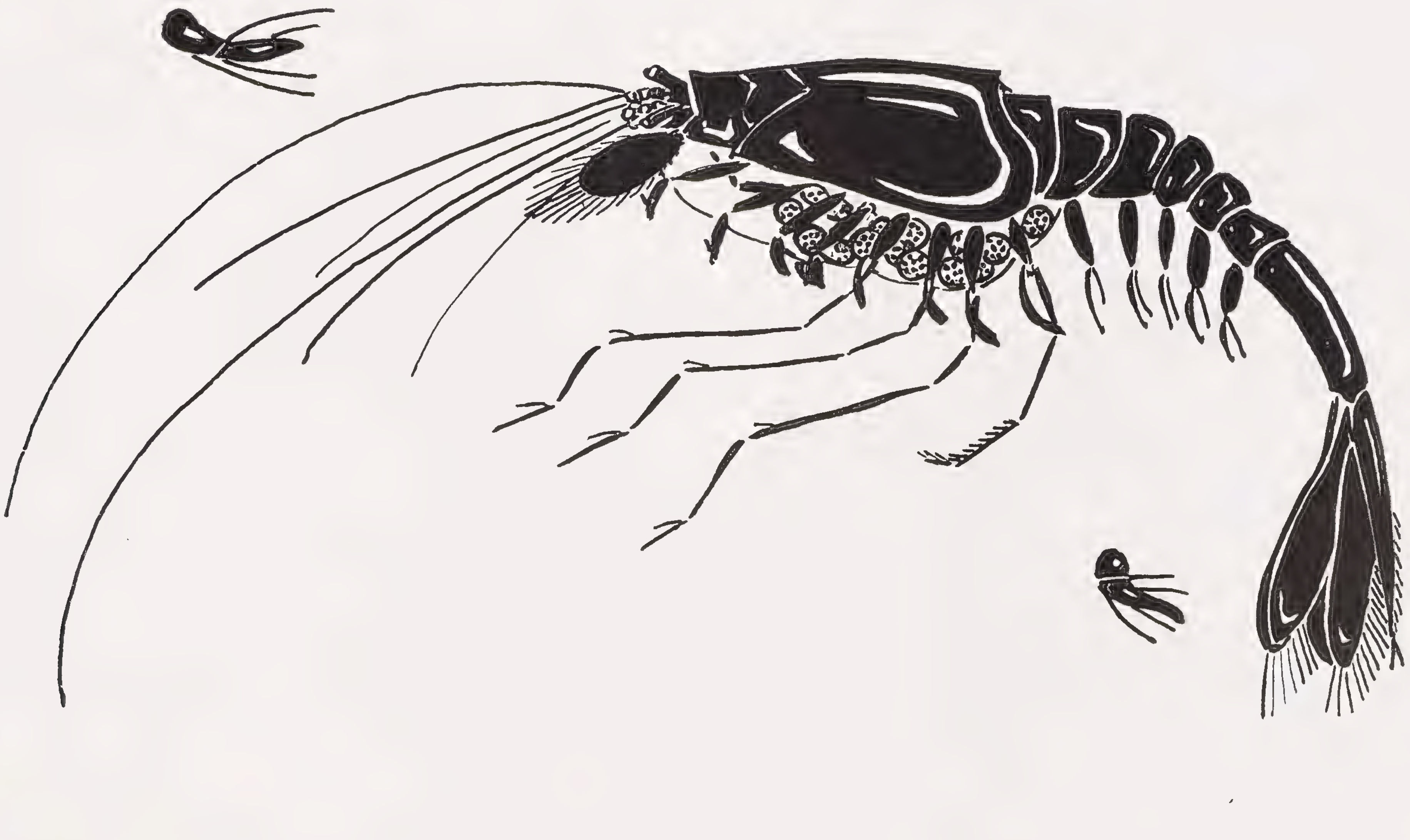
sequently we miss that odoriferous physical contact with our prey which is the privilege of other fishermen. The first time I touched and felt and actually smelt a fresh-dead, jet-black, purple-lighted sea-dragon, and realized that it was *fish*—that was an experience I shall never forget.

There was a satisfying variety of fish today, most of them dwarfs compared with the dragonfish. Cyclothones, or Round-Mouths, were there in their usual abundance. We catch twice as many of these deep-sea fry as of all the other fish put together; more than a hundred frequently come up in one net. Why they should be so abundant in our area is one of our unsolved riddles. Most of those in the four-hundred-fathom net were grayish Pallid Round-mouths, and the whitish young of dark-brown Abyssal Cyclothones. But in the deeper nets the majority were well-grown fish of the abyssal form.

Myctophids or lanternfish, from a half-inch to two inches long, were next in number. All of these have small lights scattered over their bodies, forming characteristic configurations as constant within each species as the constellations of the Zodiac.

In one net was a small cousin of the Rose-lighted Dragonfish. It was a *Photonectes* only an inch long, but as black as the giantess, with the usual double rows of violet port-hole lights along its side, and a blazing green barbel bulb dangling under its chin. This faded to white within an hour of its capture. There was a rare black anglerfish, a *Melanocetus,* which carried a silvery-white lamp on a stalk arising from the middle of his snout. There were a couple of young Thread Eels, slender as angle-worms. Their jaws were drawn out to a wiry fineness, with the tips curving away from each other without the least apparent reason. Yet in the stomach of each we found a good-sized shrimp. Whatever their hunting handicap, these fish are successful; they are among the most common of the deep-sea eels.

Finally, there were numerous small, pale, larval fishes. As in all the other large groups, young fish predominate, and for two very good reasons. Our nets, which must be drawn with a pitiful slowness at only two knots an hour, are less likely to miss weak young animals, whatever their phylum. Also, just as there are



more human children under twelve than old 'uns over seventy, so more young sea creatures than old have escaped the fate of being eaten.

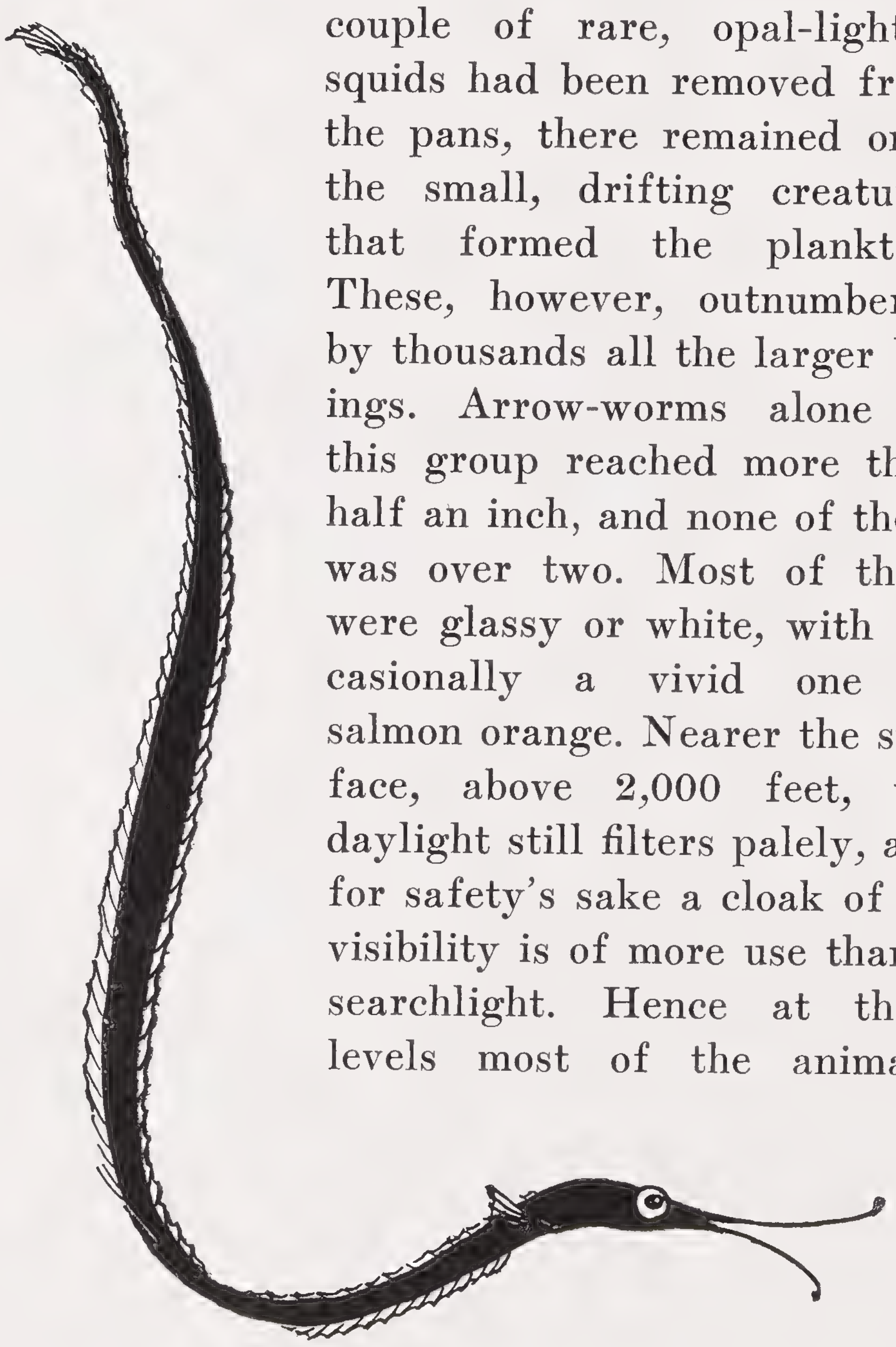
I almost missed one of these youngsters. Only a round silver eye and three black spots showed in the bottom of the pan, and yet I lifted out the larva of the Thread Eel. And I wondered again at the transformation that changes a broad, flat, glassy sliver of a fish into the slim, round, black creature that is the full-grown eel.

How relatively unexciting is this "coming of age" in humans! Suppose that useful abstraction, the ant-man from Mars, suddenly swooped down over Africa and gathered a miscellaneous collection of jungle mammals. Obviously, he would have no difficulty in separating all the infant Hottentots from the monklets and lion cubs and three-weeks-old elephants; and without so much as one wrong guess he could add them to the jar that held their dusky parents.

On the other hand, many of the so-called lower animals, especially ocean-living ones, transform themselves completely in the ordinary course of growing up. The story of even the least remarkable puts to shame the imaginations of the old frog-into-prince school of storytellers. While no human baby ever grew even one extra leg, the merest shrimp starts with six and grows thirty more in due succession. Furthermore, those original six change from capable legs into equally efficient feelers and jaws. Again, most deep-sea fish are little different, when they leave the egg, from new-hatched herring. They are weak and white and their fins are nothing much to speak of; they have only their first set of teeth and not a trace of a light organ is anywhere upon them. Great fangs and flashing lamps are yet to be formed, and the fact that their development is a very usual process down there in the darkness does not make it any less wonderful. Could we for a season change places with the dragonfish, keeping with us only our present mentalities, think of the thrill attending the first flash of small Jimmy's cheek-light, and Mrs. Johnson's pride in Susie's blackening complexion!

I jerked out of this unscientific day-dream at the Director's call to come and watch more fireworks. He had brought a prawn (*Systellaspis*), much revived, from the ice-chest, and it was still of that glorious shade of brilliant scarlet that is peculiar to deep-sea shrimps. In the dark room we watched its last display, as it shot out a small, defiant cloud of luminous fluid. In spite of its brightness, I knew this was but a shadow of the shrimp's performance in the blackness of the ocean.

When all the fish, the larger shrimps, and a couple of rare, opal-lighted squids had been removed from the pans, there remained only the small, drifting creatures that formed the plankton. These, however, outnumbered by thousands all the larger beings. Arrow-worms alone of this group reached more than half an inch, and none of these was over two. Most of them were glassy or white, with occasionally a vivid one of salmon orange. Nearer the surface, above 2,000 feet, the daylight still filters palely, and for safety's sake a cloak of invisibility is of more use than a searchlight. Hence at these levels most of the animals, from the youngest lobster to the largest of the dolphinfish, have either bodies of crystal or coats of blue and silver, and the glassy worms are no exception. The entire catch today, however, was made between 2,400 and 5,400 feet, and so there were orange worms, red shrimps, the blackest of fish, and many lighted forms.

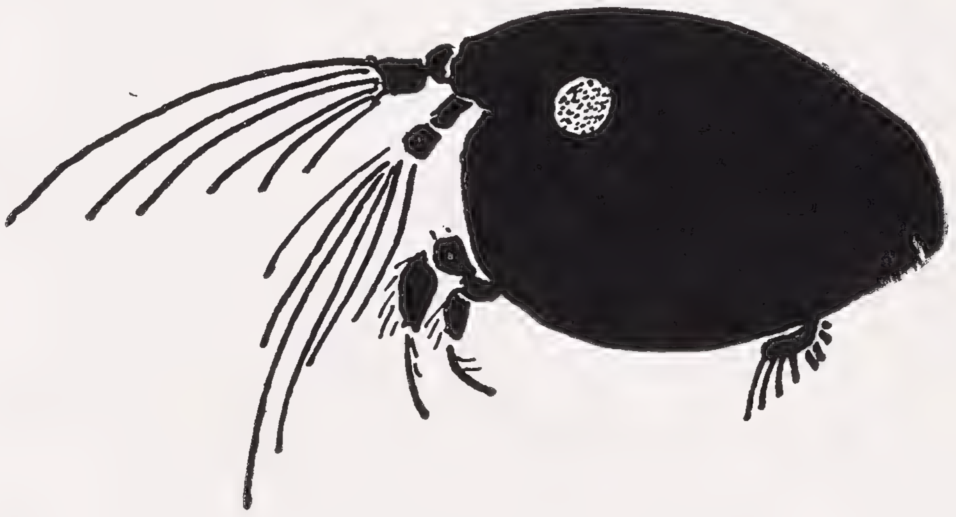


These white arrow worms, although they carry no lights, thrive at all levels. They shoot through the water with flicks of their tail fins, and seize their prey with tufts of scythe-like brown bristles which grow around their mouths. More than once we have found small fishes in their stomachs—always, somehow, a disconcerting discovery. It upsets one's New England sense of logical order. Fish should eat worms, not worms fishes. Anyway, the fact remains that arrow worms are more numerous in our nets than any of the non-crustaceans.

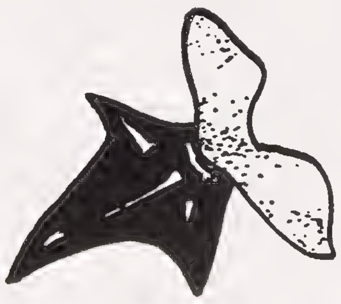
Running these a close second are the jellyfish-like colonies known as siphonophores. Most of these have one or two glassy swimming bells, pointed, many-sided and rather like a bishop's mitre. From below dangles a short chain of pale gold polyps, some adapted for catching and devouring prey, some concerned solely with the production of the next generation. The large, complicated forms, represented at the surface by the Portuguese-men-o'-war, do occur in the deep-sea also, but in our nets we find only the broken fragments of their bells.

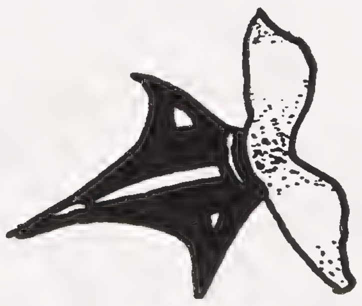
At last only a soup-like pinkish fluid was left. I placed a spoonful in a watch-crystal under my microscope, felt the familiar cold of the steel against the sides of my nose, pressed my eyes to the oculars, and settled to the happiest part of the evening's work. I do not know of an easier way of changing worlds. It is simply a question of spectacles. But all your scales of size and values vanish; your own five-feet-something-or-other of height never existed; your coarse Brobdingnagian perception of "pink soup" is forgotten completely. Instead you are an unimportant something hovering just above a zooful of unbelievable creatures, all with waving legs and shining eyes and bodies crystal-clear, or glowing with every color of the rainbow.

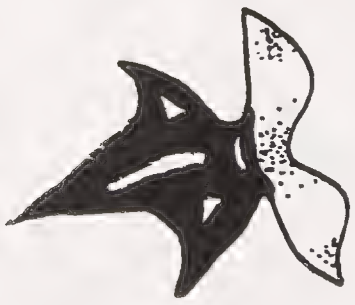
There are small, bivalved crustaceans, akin to barnacles and known as ostracods. Superficially at least they resemble shrimps that never grew up, for after hatching they add only eight limbs to the six with which they started. From the first, they shut themselves, oyster-like, within a pair of shells grown from the chitin of their backs.



Somewhat resembling these are flying snails, the pteropods. The shells of some are burnished shields, others are flattened spirals tinged with violet, and still others are slender cones of alabaster. Most of the bottom of the Atlantic ocean is covered with clay, or with the skeletons of minute, one-celled radiolarians or foraminifera. Off Bermuda, however, there is a small patch of Pteropod Ooze, the only one in all the northwestern Atlantic. Why these snails should thrive exceptionally well in this particular spot is only one of the innumerable puzzles which we have not solved.

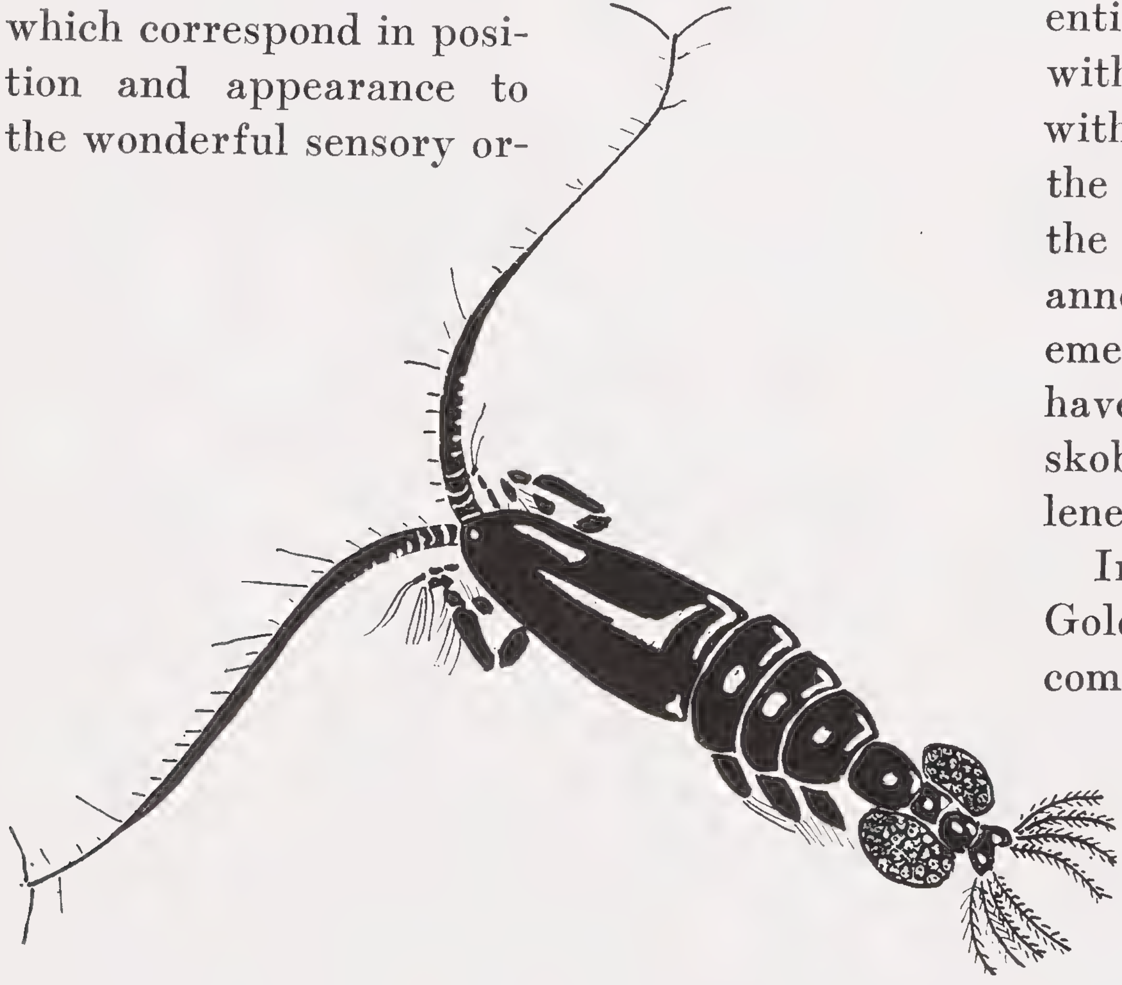




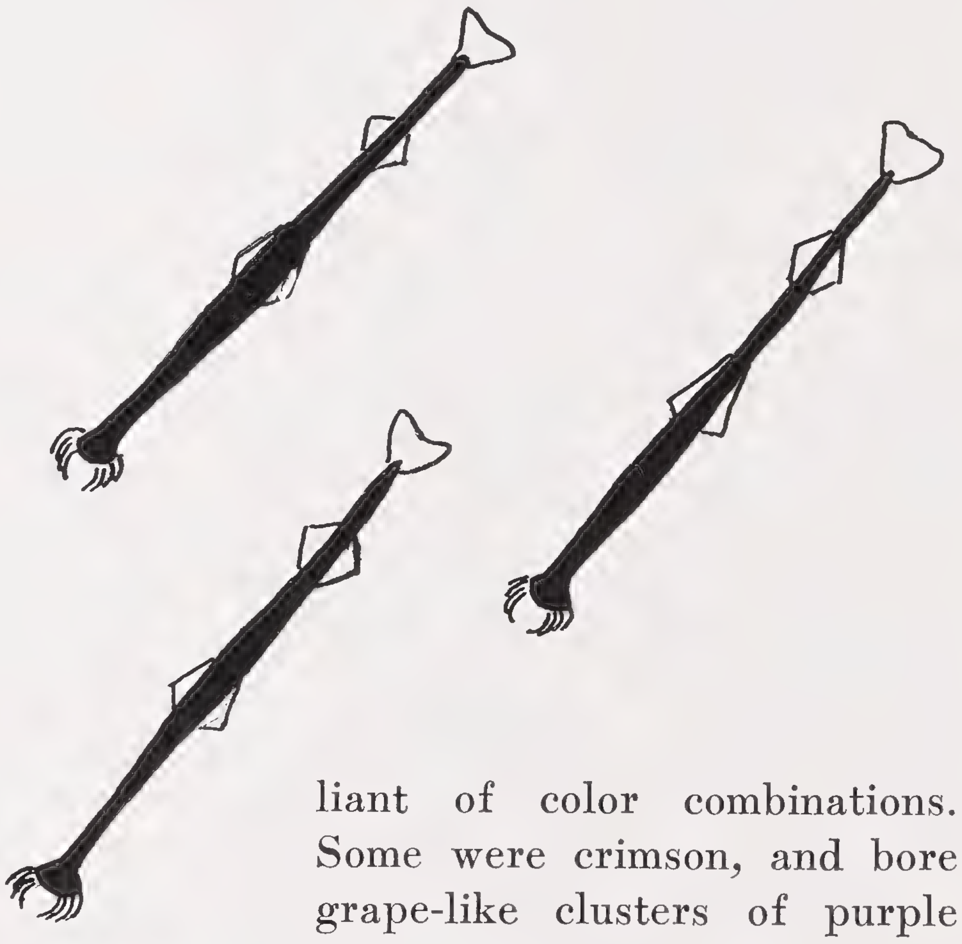


Amid the welter of legs and eyes I caught sight of a full-fledged anachronism a tenth of an inch long. If a pan-American airman should trail a net behind his plane and, five thousand feet higher than the jungle treetops, catch a curled-up infant armadillo, this would be scarcely more absurd than our netting a starfish a mile above the nearest solid ground. Only because we are somewhat used to the idea can we with scientific calm catalogue a baby crab caught swimming in mid-ocean. We have long known, however, that many animals which pass a staid and tame maturity lazing among the reefs, crawling in the tide-pools, or even fastened tightly to a boulder, enjoy an obviously exciting adolescence in the open sea. Most of them, be they fish or crabs, barnacles or lobsters, live in these free days near the surface. But some, like the leptocephalid larvae of our fresh-water eels, are probably spawned hundreds of feet down. To this latter group the small starfish may belong. More probably, however, it was one of the few animals captured by the net on its way to the top.

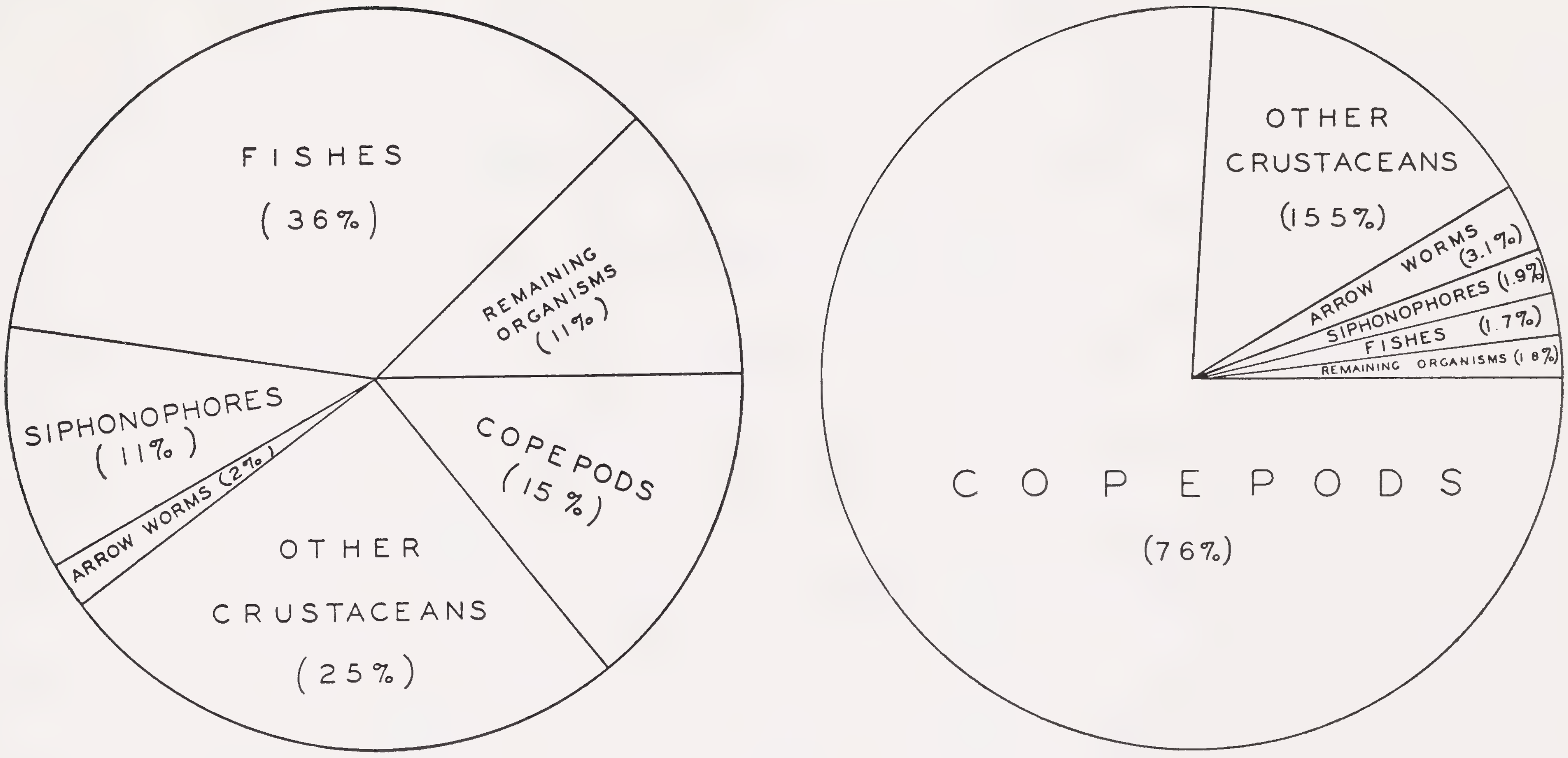
In my study of the pink spoonful in the dish, I purposely ignored, until the last, the copepods, the ubiquitous small crustaceans which have justly won the name of "insects of the sea." I ignored them because I knew that once they had distracted my attention, I would quite forget snails, starfish and everything else. The longest of them measure less than half an inch; the smallest are only a twenty-fifth as large as these. They are of all forms, but most have a torpedo-shaped body with a slender, jointed, legless tail ending in a few feathery bristles. Almost all have only a single eye, set Cyclops-like in the middle of their foreheads. They row themselves along by jerks of their antennae, those long "feelers" which correspond in position and appearance to the wonderful sensory organs of ants and butterflies. Suddenly to find such organs used as oars is as astonishing as it would be to see a donkey swimming with his ears.



Many of the mites under my microscope were transparent, but others flaunted the most brilliant of color combinations. Some were crimson, and bore grape-like clusters of purple eggs; some were clear ultramarine, with ruby eyes and legs of gold; and one was flame scarlet in front, but had tail and underparts of livid magenta. In the audacity of contrast, in the brazen effrontery of clashing hues, they reminded me of the costumes in some old medieval tournament; considered analytically the discords were atrocious; accepted emotionally, the effect was perfect. Luckily for scientific accuracy, we have a book of color samples with every shade catalogued and labeled, and with this we match the almost nameless colors of the copepods. But although I faithfully make the proper records in my notes, it never fails to annoy me when a creature all sapphire and emerald and delicate heliotrope turns out to have its "cephalothorax smalt blue, abdomen skobeloff green, and antennae pallid napthalene, shading into Schoenfeld's purple"!



In the ocean there is no such thing as privacy. Goldfish globes are stone-walled hermit-cells by comparison. No jointed-legged being, from a queenly scarlet shrimp to the smallest of the copepods, could ever find a safe place to leave her eggs. She cannot, wasp-like, choose a likely space and dig a hole; neither can she glue her eggs to a food-



The Proportions of the Principal Groups of Animals Caught in a Typical Deep-sea Haul. In the right hand circle the percentages are based on the numbers of individuals; in the left circle, on the relative bulk of the various groups. These proportions are derived from a single haul of six Michael Sars metre nets, drawn at two knots an hour for four hours, at 400, 500, 600, 700, 800 and 900 fathoms, from eight to ten miles off Nonsuch Island, Bermuda, on July 25, 1934. With the single important exception that almost all protozoans slipped through the meshes of the nets, and so are not shown in the above diagrams, the latter give an approximate idea of the proportions of the various groups in the deep sea. If the protozoans could have been caught and counted, the representation of their numbers would probably have occupied almost all of the right hand circle; the divisions of the left one, however, would scarcely have been affected.

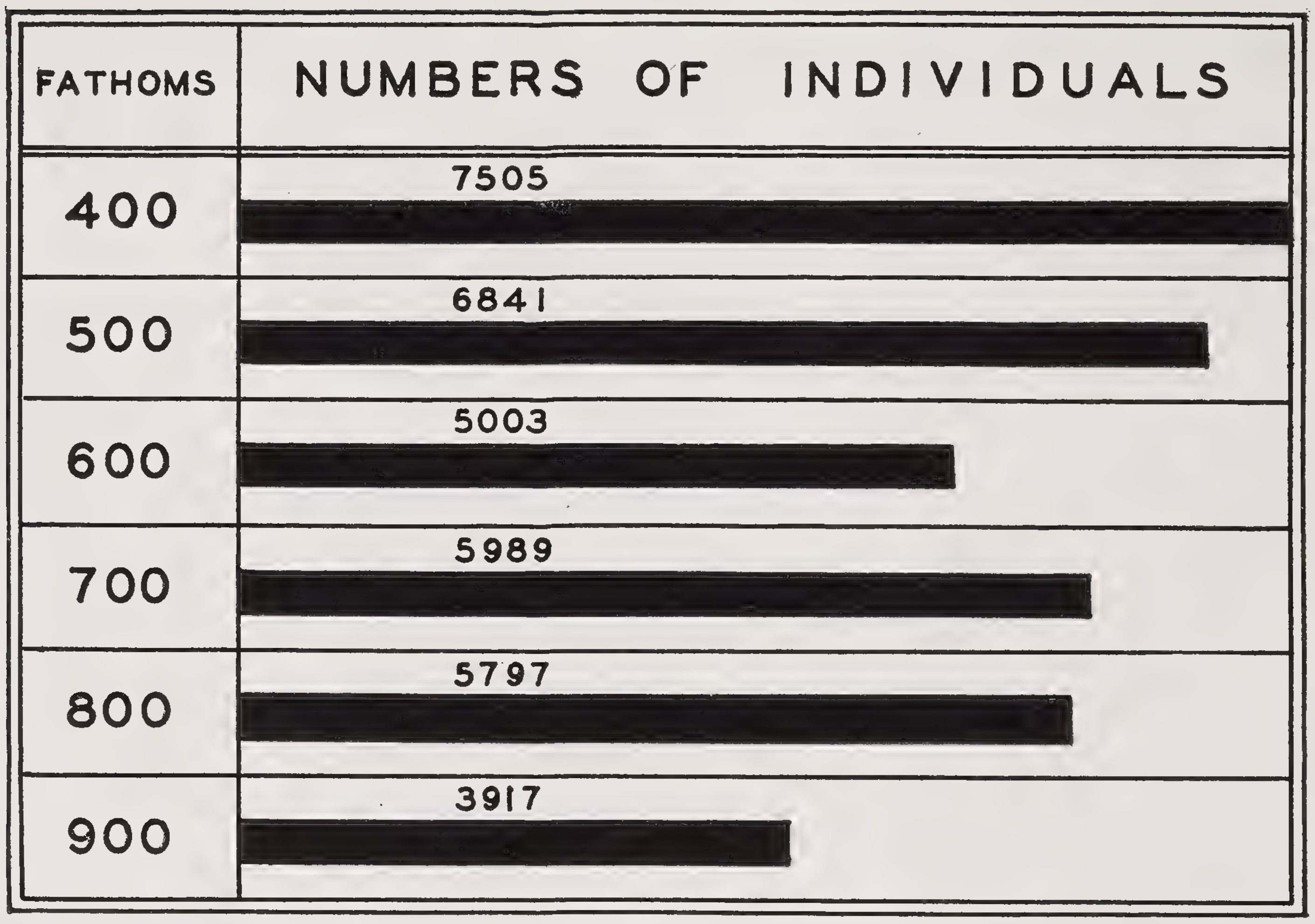
filled slice of water, like moth-eggs to a leaf. And so she quite wisely carries them around with her in a pouch beneath her breast, or attaches them firmly to her swimmerets, or, as in the case of many copepods, she slings a packet pannier-wise on each side of her tail. Fish are not so careful: most of them scatter their eggs anywhere, in great numbers. But the following list shows how camparatively few are the fish and other organisms in comparison with the crustaceans. It is based on a single, typical haul of six nets drawn between 400 and 900 fathoms. Except that the minute one-celled animals, almost all of which slip through our nets, probably lead all the rest, this list gives a fairly accurate idea of the relative numbers of the principal types of organisms:

Copepods	76. %
Other Crustaceans	15.5 %
Arrow Worms	3.1 %
Siphonophores	1.9 %
Fishes	1.7 %
Radiolarians	1.2 %
Segmented Worms	0.3 %
Mollusks	0.08%
Peridinean Shells	0.07%
Tunicates	0.07%
Echinoderms	0.05%
Jellyfish	0.027%
Comb-jelly	0.003%
Total	100.000%

The circle at the right shows this list in diagrammatic form, the left circle the relative amount of space the individuals of the same groups occupy. Even in this latter arrangement, with large and bulky fish as rivals, the crustaceans still lead. This order is practically invariable at all depths, although the relative proportions of the smaller groups vary slightly.

It is now clear that the copepods are the most important of the middle-men in the deep-sea, the links between the plants, the ultimate producers, and the large fish which are the last consumers. The wonder of it is that so many copepods, sought by innumerable hungry enemies, live to grow and carry their small parcels of eggs. The key to their abundance lies of course in the rapidity of their development. Some are known to complete their entire life cycle in a week.

We capture a minimum of several thousand copepods in each net, and this is but a small



This chart shows the gradual decrease in the numbers of deep-sea animals caught between 400 and 900 fathoms. It is based on the single Bermuda haul described.

fraction of the numbers our nets fail to catch. Once I devoted hours and days to the task and sorted and counted all the copepods in a single haul. Then, after an astronomically involved calculation full of pi's and decimals and ciphers, I found that in spite of these counted thousands, each small copepod apparently swam lonesomely in a cube of water measuring twenty-one inches on a side. With the counts of other regions in mind—I recalled that at the surface of the North Sea a distribution of one copepod to the cubic inch was not uncommon—I carried my calculations to the Director. I rather expected him to be impressed with the scantiness of life in his deep-sea cylinder, and was puzzled when he merely grinned and said, "All right. That's fine. But wait a bit." Two weeks later I had the joy of going down in the bathysphere and seeing things for myself. When I returned I took all my calculations and quietly tore them up. The multitudes of swirling copepods I had seen from the window brought home to me as had nothing else the inefficiency of the best of deep-sea nets, not only in capturing large fish, but even in retaining the small planktonic animals.

I have said that the copepods are the most numerous of the mid-links in the oceanic life-chain. The microscopic plants, dependent as is all vegetation upon the sunlight, form ultimately the food of even the largest deep-sea dragon. But sunlight penetrates only a little way into the sea, and no plant can live much below 600 feet. Visible daylight dies out completely at 2,000. All of the creatures in our nets lived from 500 to 3,500 feet below the last glimmer of daylight. The copepods, although they are noted as scavengers of all kinds of organic rubbish, are mainly vegetarians. Consequently the thousands we caught in the middle depths must have depended principally on the remains of dead plants drifting downward toward the bottom.

We find that below half a mile the plankton, and consequently the larger animals, gradually become less numerous (chart). This, viewed in relation to the distribution of the plants, is quite understandable. A diatom-plant, living at the lowest possible level in a minimum of light, somehow escapes being eaten and dies of old age. Its beautifully adjusted floating organs promptly cease to function. It becomes water-logged, and begins its long, slow fall to the bottom, a mile and a half beneath it. Every yard of its journey it passes tens of hungry copepods, and the chance of its escaping consumption long enough to reach the lower levels is slight. It follows that as there are considerably fewer defunct diatoms at the depths of a mile than at half a mile, there is an even scantier assortment of lanternfish, and so on. But between 2,000 and 3,500 feet the life of the deep-sea thrives. Here the blackness is of full intensity, and the cold nears its maximum, so that all the lanterned black and scarlet creatures of the mid-depths swim, feed and find their mates in the environment for which their outlandish characters are developed; yet the sunlight is not so far above them that they lack an abundance of food.

I realized suddenly that it was very late and I was tired. Rows of shiny glass vials, each with its own typed label, had replaced the chaos of pans and pails and dishes. I had covered my microscope and pushed in the final cork when I saw a small dish sitting forgotten in a corner, holding *Omosudis,* the subject of the artist's last color sketch. It was a frightful, two-inch, monster of a fish, with sabre-sharp fangs, a mild blue eye, and a stomach literally bursting with the knobbly bulk of an inchling Silver Hatchetfish. I knew that inside the Hatchetfish was probably a mass of copepods, and inside each copepod a bit of oceanic vegetable, and inside that—but I was too sleepy to look up formulae in bio-chemics. I transferred the Sabre-tooth to a round, squat jar, and placed him, bulging, on the shelf. And through my head danced the lines:

"Oh, I am a cook and a captain bold,
  And the mate of the *Nancy* brig,
And a bo'sun tight, and a midshipmite,
  And the crew of the captain's gig."

I could have sworn that through the curved, distorting glass, *Omosudis,* alias "the Elderly Naval Man," licked his fishy chops and grinned.

American Fresh-water Eels in Bermuda

WILLIAM BEEBE and JOHN TEE-VAN

ARISTOTLE and his pupils were perplexed by the mystery of the life history of the European Eel, and more than two thousand years passed before this was solved. Dr. Johannes Schmidt devoted eighteen years of his life to the problem, and before he died, last year, had the satisfaction of having discovered all the important facts of this almost unbelievable life history.

The eels of the North American continent and of Europe, when they become adult, all make their way from the ponds and down the rivers in which they have been living for years, and when they reach the sea they swim thousands of miles south until they come to the deep waters of the open ocean near the West Indies. There they mate and spawn, after which every eel dies. The young eels, minute and transparent as glass, work their way slowly northward. Weak swimmers as they are, they manage somehow to travel on and on. Beginning life five hundred fathoms or more beneath the surface, and four thousand miles away from their parents' rivers in Europe, they push on. The American eels breed somewhat to the westward, but not so far but that the two leptocephalids or larvae commingle. I have taken both in the same net.

Bermuda holds a unique position in relation to these young eels, for it stands at the dividing point of their migration. Somewhere in the vicinity, the two great hordes of glassy eellets split to east and west, the European ones taking two years or more on their journey, and the American eels reaching their home rivers in half that time. As little, pink, fingerling elvers they swim up into fresh water, and remain there from six to eleven years. Then the utterly mysterious call comes, and they all start down, out to sea, and south to the tropics, and dive into complete blackness (I know, for I have been

American Eels Recently Caught in Brackish-water Ditch, Bermuda. Photo by John Tee-Van.

there!), where they in their turn, go through who knows what ceremonies of courtship and mating, lay their eggs and die. I have overlapped the circle intentionally, for only by reiteration can we really come to believe this astounding round of life.

For years we had heard rumors of fresh-water eels in Bermuda, but they always turned out to be blackish morays, or else references to twenty years ago. On page forty of our recent volume on the Shore Fishes of Bermuda*, we limited ourselves, concerning these eels, to one sentence, "In Bermuda recorded from brackish ponds." We had seen no specimen except in a collection at Harvard, where a two-inch individual was said to have been taken in these islands. Besides this, there seem to be no recent records, verbal or published.

In 1876 Brown Goode wrote of the eel, "Common in the ditches and dikes of the salt marshes," and quoted Mr. J. M. Jones "that it attains the weight of two or three pounds, and is very destructive to ducklings. It is not eaten." By diligent inquiry I found people who had speared or jigged for eels, ten or twelve years ago, at night in The Lane near Hamilton. Mr. Scarritt Adams had caught full-grown eels, three feet long, at the same place, and said that they were considered a great delicacy.

At present, so many salt marshes and ditches have been filled in, there would seem no suitable places for fresh-water eels to live when they had passed the larval stage. I gave some eel pots to my young ichthyological enthusiast, Thatcher Adams, and bade him try to catch eels. He set them without success in a mangrove swamp at Spanish Point, and then tried in a ditch tributary of the swamp, in Hamilton itself, not far from the Hamilton Hotel. The next day there were six in the trap, twelve to fourteen inches in length, and all perfectly good American Eels (*Anguilla rostrata*). There is not much external difference between eels from opposite sides of the Atlantic, but the number of the vertebrae is characteristic. The American eel has from 103 to 113 segments in its backbone, while in the European form there are 111 to 119. In our Bermuda specimens the vertebrae average 105.

Our eels were well-colored, rich bronzy green above, changing through golden yellow to white below. The iris of the eye was iridescent bronze gold, thickly dotted on the upper half with black. The water in the ditch in which they were taken rose and fell with the tide, but a bottle-ful taken at the time and place of the eels' capture was quite blackish, with a salinity exactly half-way between salt water from the sea, and rain water.

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* *Field Book of the Shore Fishes of Bermuda* by Beebe and Tee-Van.

The most interesting thing about this discovery of half-grown eels, in this back-water of Bermuda, one mile from the open water, is that these few individuals, out of all the uncounted hosts of larval eels which pass Bermuda every year, are the only ones to be deflected to this first available, but unattractive and barely possible living haunt. If we are to judge this event by the habits and instincts of all other eels, the parents of the eels now living in Bermuda must have spent their existence, from larval to adult life, in this same ditch.

We are today as ignorant as ever of how the European Eels know where to go to breed (retracing their juvenile journey of years before), or how the young know to go back to the same waters from which their parents came: We know as little about all these things as Aristotle, more than two thousand years ago, knew of North America or Bermuda.

Salt and Fresh-water Viability of Fish

GLORIA HOLLISTER

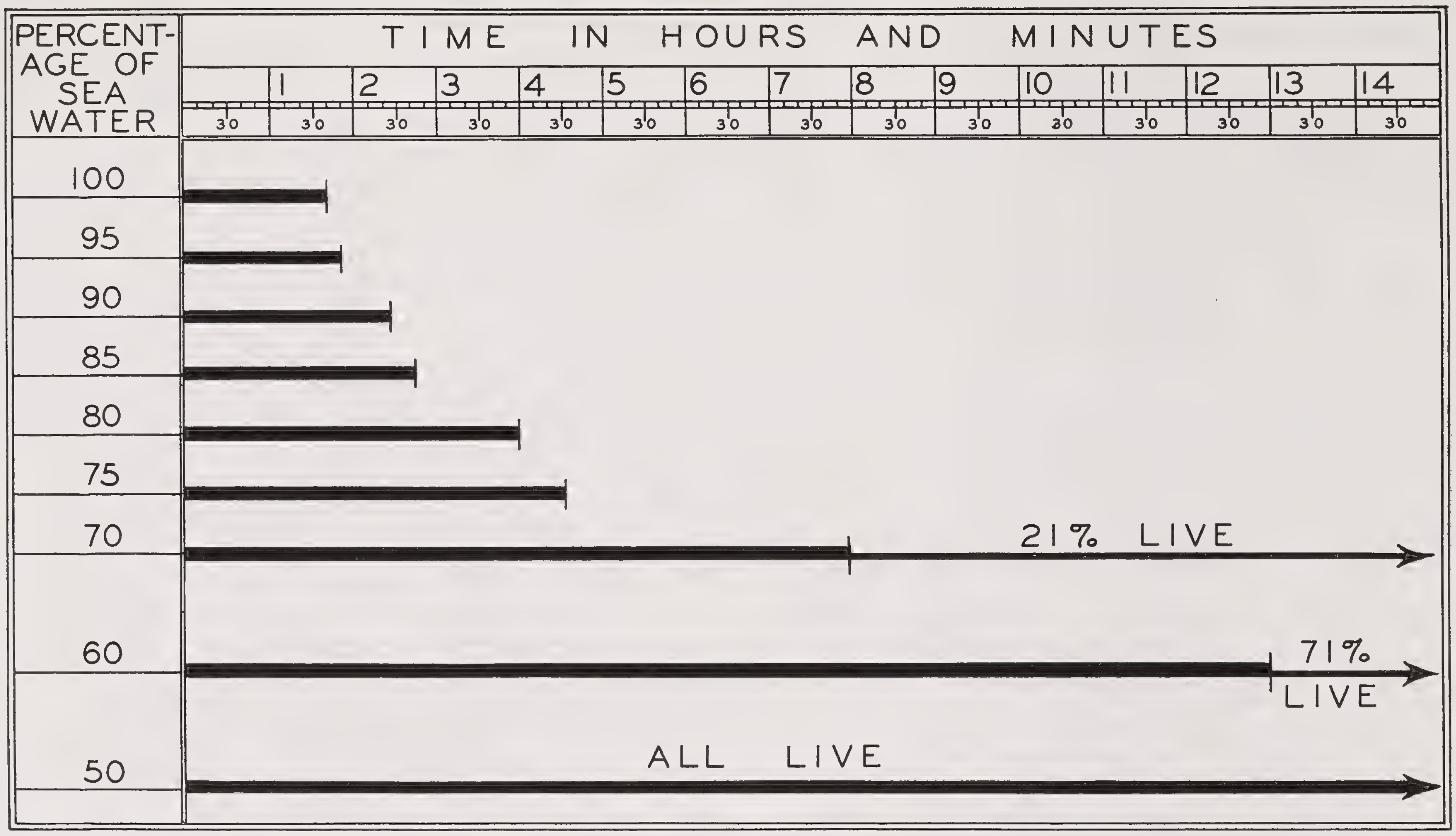
POPULAR conception naturally divides the world of fishes into two big groups:-- those living in fresh and those in salt water. We are always surprised to read of the long journey of the eel from its fresh water home far into the open sea to spawn. Annually there is an economic record of the number of salmon that are caught as they travel one thousand and more miles from the sea to inland mountain streams to spawn. With both stories, it is the distance traveled that impresses us rather than the fact that the fish has changed its chemical environment. The salmon and the eel are examples of direct antitheses.

Besides these, there are many fish, representing various families, that live in brackish water but are sometimes found in the sea or in fresh water. Cyprinodont minnows may be found in fresh water, brackish water, or even bays of the sea. The ancestors of the handsome black molly is found in all these haunts and could be kept in any water that is convenient. Other very adaptable minnows are those belonging to the *Fundulus* group which has species living under all conditions. Some are bottom fish, burying themselves in the mud of estuaries, others swim freely in rivers and bays, and still others are surface swimmers in swamps and streams and brackish water. Certain ones are found in inland lakes and ponds.

The amazing powers of rapid adaptation of three species of minnows have been observed in our Nonsuch laboratory. Two of these are residents in the brackish water of Bermuda, the degree of salinity of which is variable, depending on the amount and frequency of rainfall. An available analysis of the Devonshire Marsh water gives a pH of 6.9 as compared with 8. plus of the surface sea water. The two minnows mentioned are *Fundulus bermudae* a native, and *Gambusia holbrookii.* The latter was imported from fresh water pools near Washington, D. C., in May, 1928, and planted in the brackish marshes where they are thriving, and are valuable as feeders on mosquito larvae. The third form observed is the guppy, *Lebistes reticulatus,* a tropical fish, recently introduced into a few garden pools in Bermuda.

Fundulus bermudae, known also as the mangrove mullet, or mangrove minnow, is found in secluded mangrove bays as well as brackish pools. As far as we know it has never been reported swimming freely in the sea along the shores. In all these brackish water localities there is a definite rise and fall of tide. Our specimens came from a shallow mangrove swamp inland from Castle Harbor on the western tip of St. Davids Island. This small, flat-headed minnow is valuable as an enemy of mosquitoes and adapts itself quickly to fresh or salt water, without any intermediate steps in half and half solutions. It lives peacefully in fresh water pools with goldfish.

The *Gambusia* coming from the brackish



Guppy Viability Diagram. Average viability in hours and minutes of guppies plunged into solutions of salt-water, ranging from 50% to pure salt-water.

marshes will also live in either salt or fresh water, but differ from *Fundulus* in rapidity of adaptation. *Gambusia* need a few days (1 day was successful) in a 50-50 per cent solution, before thriving in pure salt water. Placed directly in salt water they survive about 3 hours. Later it was found that of the cyprinodont minnows the guppy is the least adaptable to salt water, needing gradual changes over a period of about a week.

Probably the best known of the minnows is the guppy, which for generations has been reared in fresh water tanks in many homes. Serious fanciers have developed the rainbow colors of the male far beyond that of its ancestors in Trinidad and northern South America.

During several years of personal observation the guppy has lived up to its reputation of a remarkably hardy little fish, surviving extreme sudden cold or heat, shifts into unseasoned water and travel in crowded and unaerated quarters. Last winter, finding my aquariums in New York City over-stocked with guppies I used this minnow first in a series of viability tests in solutions of salt water. Half grown fish were the subject in a constant total of two quarts of water, in both jars and open rectangular tanks. Repeated experiments have shown that the differences of surface area of these two containers have had no appreciable effect on the longevity of the guppies. No plant life or aeration were introduced. Salt water was supplied through the courtesy of the New York Aquarium from December 1933 to May 1934 when all the experimental fish, as well as the stock, were transported to our Bermuda Laboratory with the 20th Expedition of the Department of Tropical Research. Here this work was continued, and in addition, a number of the commonest types of Bermuda shore fishes were observed during the summer. I was ably assisted in the constant care of the aquariums by Perkins Bass and William Ramsey, Jr., and in collecting specimens by Thatcher Adams and Robert Hartley.

The salt water fish will be described after we see how the guppies take to their changed water world.

The experiments with the guppies were divided into two groups. First, plunging the fishes directly into definite percentages of salt water, ranging from 50 per cent to pure salt water, to determine their reactions, exact time of survival, and the point where immediate adjustment would occur and life continue indefinitely. This method was used first, starting with pure salt water and working down into the weaker solutions. Only a few tests were necessary to show that in a half and half solution most of the fishes lived indefinitely. The few that were lost died of other causes, such as over heating the water by placing it too near a radiator during the cold weather. There have been no losses in Bermuda where the temperature is comfortably constant for tropical fishes.

One guppy, in a two quart jar (Experiment No. 1), which was returned to fresh water after feeling the effects of immersion for one hour in pure salt water, fully recovered in seventeen hours and a half and was then placed in a 50 per cent solution. This guppy, after eleven months (in November), is still living in the original solution of half fresh and half salt water. In spite of the fact that there is no aeration and no plant life in the container, and only food is added, this fish has doubled his size and promises to live on to old age, or until the water evaporates. The experiment was repeated with another specimen which was placed directly in a half and half solution (Experiment No. 4), and this fish, too, after eleven months, is still thriving. Several more tests were made in Bermuda with the same results. The chart shows at a glance the average longevity in the various percentages. It is interesting to note that the greatest differences occur between 50 and 75 per cent and that the longevity in each of the weaker solutions is approximately twice that of the next stronger solution.

The other method and the more tedious one, sometimes taking months for results, but one which, with the guppies has proved successful, is that of gradually increasing the percentages of salt water, starting with a solution of 50 per cent.

The female of a half grown pair (Experiment No. 5) started in a 50 per cent solution, and after many weeks in increasing amounts of salt water reached pure salt water in seven months and two days' time. She survived for only two days, having, several weeks prior to this last step, contracted a white fungus disease on the fins. The male died in a 65 per cent solution after three months and a week. Six young were born in a half and half solution (Experiment No. 6) but only two survived to come to Bermuda the first of May. They were healthy young males but unfortunately one killed the other. The remaining one was placed with the original female, its mother, with the hope of more readily establishing a salt water adapted race of guppies from those born in a solution of sea water. But this fish died, at the same time, and of the same disease that killed the parent. Another group of five, four half grown and one adult female (Experiment No. 7), was started in Bermuda on April 20 in 50 per cent salt water, and run up in half the time of the first pair, in increasing amounts of 10 per cent at each step. They finally reached pure sea water in three months and two days. During this time the adult fish had one young born on June first in 65 per cent salt water and five more born on July first, and one on August 28 in pure salt water. All the young are now living in 100 per cent salt water. All of the original group are living on the date of writing, November 20, and the large female has had another family.

Finally, having a group of nine guppies, of all sizes and both sexes, live in salt water after many weeks of prolonged stays in each progressive per cent, I was interested to find out how rapidly the guppies could adjust to salt water. So, a half grown pair was started in a 50 per cent solution and every twenty-four hours the fish were changed to a solution which was increased ten per cent. In six days this pair was in pure salt water. For three months they have thrived. The fish are given a weekly change of salt water but no plant life or aeration. This experiment was successfully repeated (Experiment No. 39) with a group of twelve fish, young to half grown.

Now that the guppies are breeding in salt water it will be of great interest to see what structural or color changes may occur in future generations. In the present generation there is one marked abnormality. This we have called "the spirals." All fish show this strange way of swimming, first being effected when in the higher per cents of salt water. "The spirals," which is what the word implies, is swimming around and around, either right side up or upside down, or sometimes alternately one way or the other. This occurs regularly when the fish are startled and lasts for some seconds after the first stimulus. The sudden flash of a light will start all the fish swimming in spirals, some more violently than others.

With the knowledge of this ability of certain fishes to live in water varying from salt to fresh, and the comparative adaptability of *Fundulus, Gambusia,* and the guppy, it is of interest to study strictly salt water groups and test their capacity for adaption to fresh water. Through extensive experiments there might be gained some hint of ancestoral relationships. The potentiality for adaptation may be preserved through heredity or lost through generations of constant conditions, in the latter case sudden changes of physical environment might mean extinction.

In the salt water fishes more specimens and repeated experiments carried on over a longer period of time are required before any conclusive data is possible. But what has been observed in these few scattered groups is indicative of possibilities in this field. Adaptation of species of salt water fish to fresh water would facilitate their being kept by aesthetic fanciers, their use for aquarium exhibits, and ultimately and more particularly for scientists who are interested in studying life histories.

A greater number of Demoiselles were studied than any other group. Two species were observed, the commonest of Bermuda salt water shore fish, the sergeant major, *Abudefduf marginatus,* and the blue and yellow beau gregory, *Eupomacentrus leucostictus.*

The sergeant major was tried in plunging experiments and also in a series of gradual changes over a period of weeks. The average longevity of fish plunged into 100 per cent fresh water was one hour and twenty minutes. The average of those plunged into 90 per cent was twenty-nine hours and a half. Seventeen specimens were started in the 90 per cent plunge and one-third are still living after two weeks, with only one showing the first signs of unadaptability, the loss of balance. After a week in 90 per cent all developed a progressive fungus on the fins. But none show any signs of eye abnormality which was experienced with the fish that had reached 90 per cent after gradual changes over a period of weeks. The fungus is a factor to be reckoned with and combatted in less specialized experiments. It has no place in the present scope of this thesis dealing only with healthy normal fish. Several other species in the same tank with the badly infected fish have not been affected by this fungus.

With two sergeant-majors, the fresh water solution was increased 10 per cent every twenty-four hours and in six days they had shifted from a solution of half salt and half fresh to one of all fresh water. They lived one hour and a half in the fresh water which was only ten minutes longer than the average time of those plunged directly into fresh water. Another fish was given an intermediate change of 95 per cent instead of going directly from 90 to 100 per cent. It lived twice as long as the pair that were jumped directly from 90 to 100 per cent. These fish remained healthy with no sign of fungus, which appears after an elapse of time in the higher per cent of fresh water. Three fish reached 92 per cent, one 94 per cent and two 95 per cent in the experiments allowing four weeks and more with a 1 per cent increase from the 90 per cent step upward.

Seven young specimens of beau gregory were experimented with, measuring between 9 and 20 mm in length. In the gradual changes from half salt and half fresh water to all fresh water the following summary will show briefly the longevity of each fish:

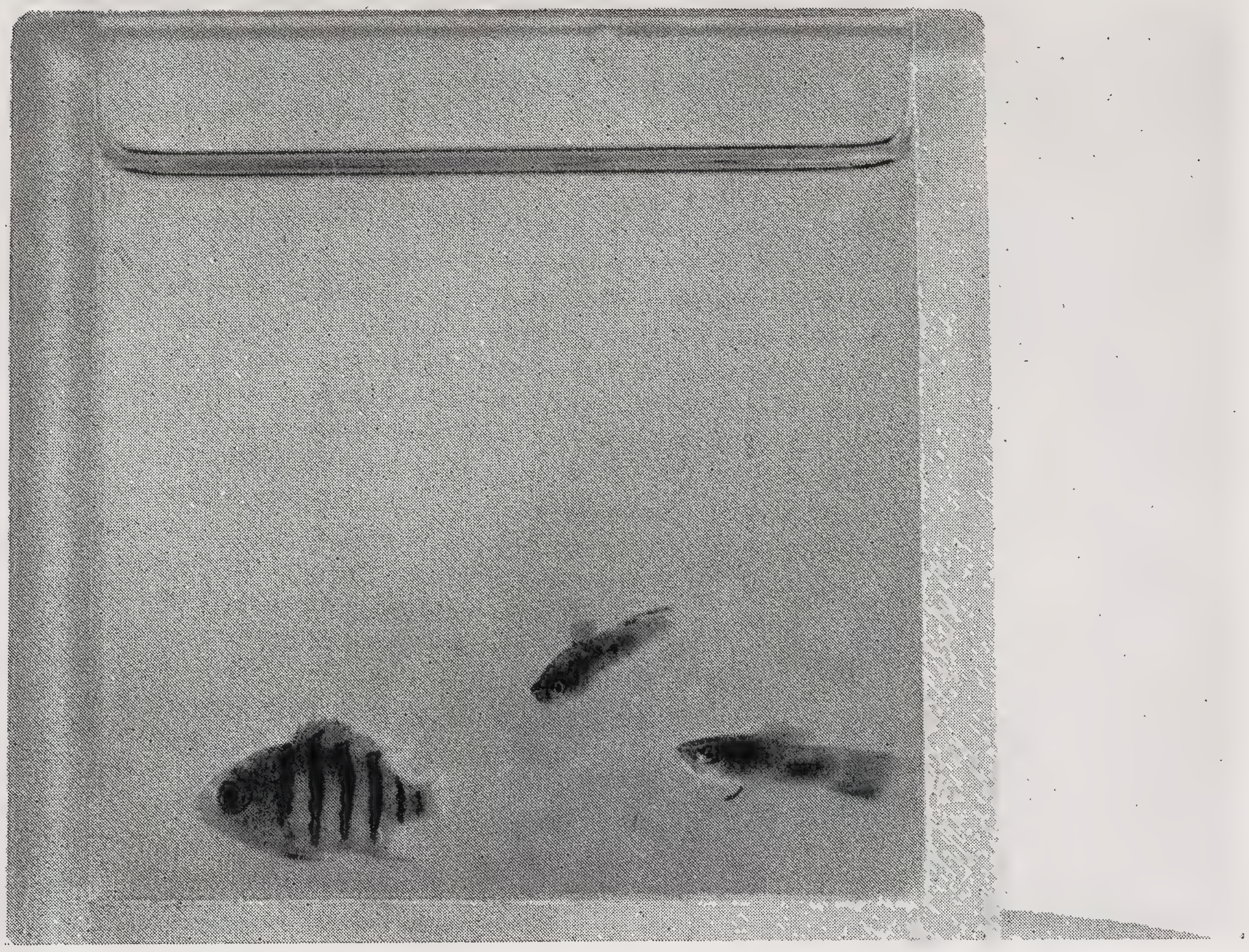
Two fish reached 60 per cent, one fish reached 80 per cent, two fish reached 85 per cent, one fish reached 96 per cent. Only one showed traces of fin fungus on the tips of the pectorals. There is one fish still living in 96 per cent fresh water.

Three specimens of silvery salt water mullets, *Mugil curema,* went into fresh water over a period of four and five weeks. One lived only four days. The mullets do not feed in captivity although tempted with a choice variety of organic material which they naturally would nose from the bottom.

One blue-striped grunt, *Haemulon sciurus,* went to 70 per cent, and one to 95 per cent. The latter was in splendid condition until changed from 90 to 95 per cent when it was affected immediately. It was returned to salt water where it revived temporarily.

Two breams, *Diplodus argenteus,* reached 75 and 80 per cent.

Several "shad," *Eucinostomus californiensis* are now living in fresh water. Only one died



Salt-water and Fresh-water Fish Living Together in the Same Aquarium: Sergeant Majors *Abudefduf marginatus,* and Guppies *Lebistes reticulatus.*

during the gradual change and this was in 90 per cent. This species feeds readily and several may be kept in the same tank, which is inadvisable with most groups, especially the demoiselles.

Two species of wrasse, the common slippery dick, *Iridio bivittata,* and a very young blue-head, *Thallasomma bifasciatum,* reached 90 per cent, excepting the young blue-head, which reached 85 per cent. The wrasse show a lack of ability to adjust the air bladder which condition was not seen in any of the other groups. They become very light with a noticeable swelling of the abdomen.

In the goby group, one specimen each of two genera and three species were observed. A translucent goby, *Lophogobius glaucofraenum,* after five weeks reaching 85 per cent by very gradual steps, jumped out of its tank when the cover was off at feeding time. This fish was vigorous and showed every indication of successful adjustment to fresh water.

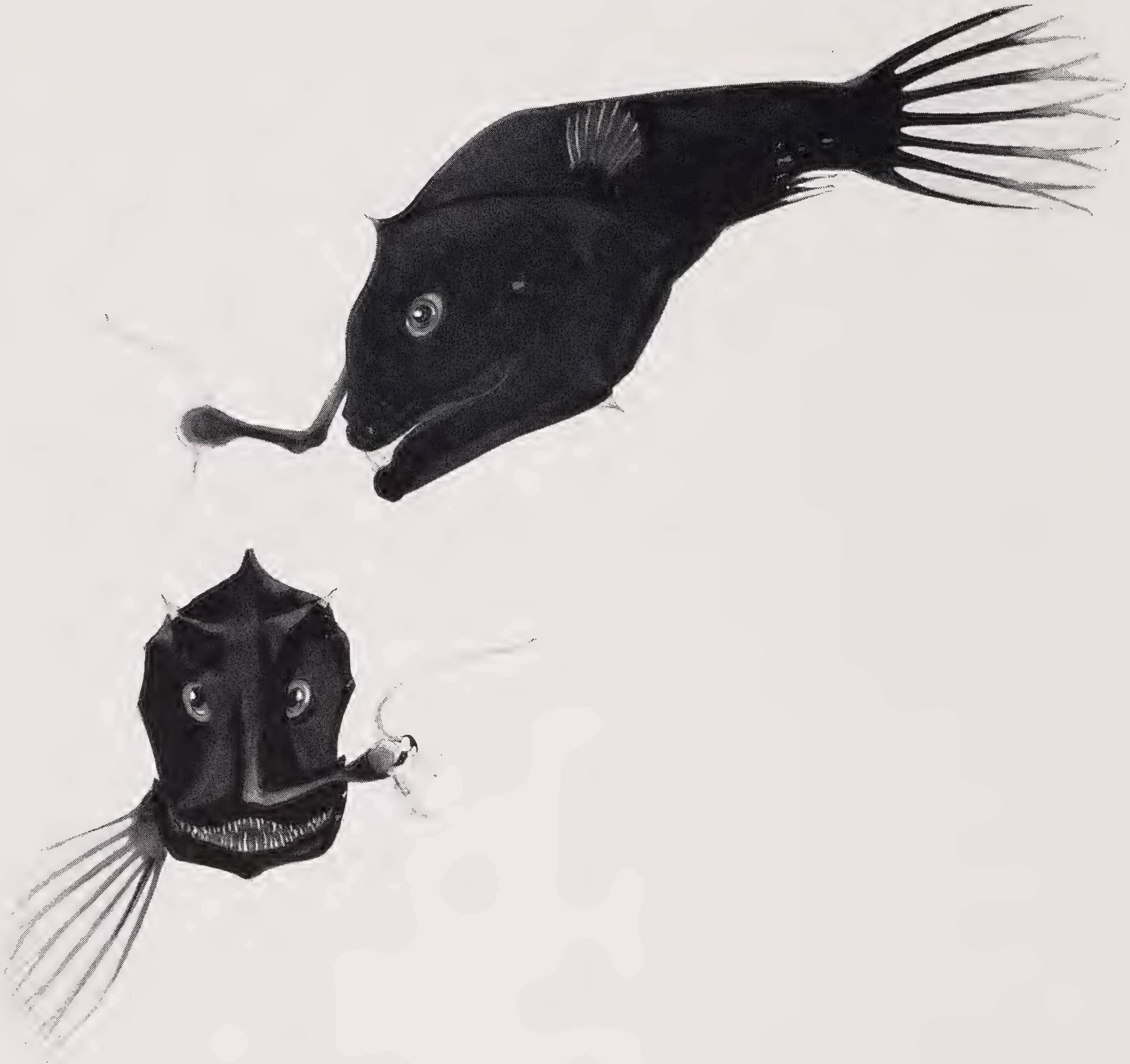
A full grown sheepshead goby, *Bathygobius soporator,* reached 95 per cent and lived on for almost a week.

A large crested goby, *Lophogobius cyprinoides* is now in fresh water after two months and a week of gradual shifting from salt water. It is feeding and apparently comfortable and happy.

In the blenny group ten specimens were observed, which represented two families, three genera, and three species. Two large *Labrisomus nuchipinnis* reached 80 and 93 per cent and one is still thriving in 93 per cent fresh water. One scaleless blenny, *Blennius cristatus,* reached 95 per cent in seven and a half weeks. Six young tide-pool blennies, *Salariichthys textilis,* reached 90 per cent in a week.

Of the pelagic fish only the amusing little angler or devil-fish, *Histrio gibba,* was tested. Under normal conditions the pelagic fish would never have to adjust to a sudden influx of water which shore fish experience at times of torrential rains. These Histrios reached 70 and 75 per cent in two weeks' to four weeks' time and one lived eight days. This dead line of 75 per cent is consistently lower than the 90 per cent which was the average life mark for the inshore fishes.

No attempt has been made to adjust the water chemically according to the needs of the various fishes. The water was kept fresh by constant changes of solutions and no plants were introduced which might foul the aquariums. Constant aeration and changes of the water kept both experimental and stock tanks in good condition. The object of these tests was to determine whether Bermuda brackish and salt water fishes could adjust to Bermuda fresh water which is rain water from whitewashed roofs.



Silver-whip anglerfish *Dolopichthys tentaculatus* Beebe.
rom Six Hundred Fathoms.

Painting by Else Bostelmann.

SAMPLE OF UNEDITED TELEPHONE NOTES FROM DIVE THIRTY-TWO

Gloria Hollister and William Beebe

Feet	*Time*	*Observations*
2450	11.00 A.M.	Big fish or cetacean came quite near; could just see outline. Was at least 20 feet long, one-third of this deep. It is icy cold in here.
2500	11.01.18	Beam off. Oxygen 1,500 pounds, humidity 63%, barometer 76.
2540	11.04	Another luminous shrimp. Ctenophore completely lighted up. Another big shrimp at window; whole thing very clear now about the luminous substance they shoot out.

2600	11.05.01	Beam on and off.
2650	11.06.29	Myriads of sparks when hit window. Big 12-inch heteropod, like *Firola.* Luminous all over, but no luminous spots. Another big shrimp shooting out luminous material which looks like a veil.
2690	11.07.50	Walls of bathysphere are ice cold.
2700	11.07.58	Hose in one-half inch. Oxygen 1,450 pounds, barometer 76, temperature 80.
2775	11.10	So black outside, and what lights! A fish with long, slender, pointed tail, this is a big fish.
2800	11.10.59	Here's a telescope-eyed fish; it is *Argyropelecus* and its eyes are very distinct. Barton sees something like necklace of silvery lights. Now another big shrimp. Beam off. Marvelous outside lights. Water filled with lights more so than on our last dive at 2,500 feet.
2900	11.13.31	Now a curved, pale-green under eye, eye lighted up by it. It is crescent-shaped. The fish at least 3 feet long. Five inch Myctophids, swimming so slowly that I can see whole light pattern. Several close lines of lateral lights, and constantly lighted plates. *Lampadena,* try to look up species.
2940	11.15	Not a flash in sight.
2950	11.15.30	Now a light coming toward me.
3000	11.16.25	Siphonophore, a big one. Oxygen 1,400 pounds, barometer 76, temperature 77, humidity 62%.
3028	11.19.14	Beam on. Beam off. Long lace-like things again. Salpa-like with big head and long, slender tendrils. Now another one.
3000	11.22.35	(Guy ropes shifted for winding in cable.)
2990	11.24.45	Animals seem to stay in field longer than at higher levels, but here comes a flash like mad! Heard metallic snap.
2905	11.25.15	(Guy rope broke with terrific snap; I learned after.)
2900	11.26.38	A lovely light. (Guy rope re-rigged, but broke again with sickening thud.) Oxygen 1,300 pounds, still coming at one liter a minute. Barometer 75½, temperature 73, humidity 6. Now three, very round fish, saw no lights at all on them. It is bitter cold inside, hand feels icy when touching window ledge (100 on deck, report).
2880	11.28.30	A squid, 8 inches, with one pale blue light and could see whole body when it passed by other lights.
2830	11.29	Now many things again, as thick as I have ever seen them.
2750	11.30.15	Mass of copepods and other plankton, can see them indistinctly 40 feet away from bathysphere. Can see a mass of little lights given out. Barton sees a big body with 1 light on each end. It may be a Melanostomiatid.
2600	11.34.28	Beam on. Saw a fish with literally hundreds of lights, about 8 inches long, from head to tail its body was peppered with very brilliant but small lights. Color of lights pale lemon-yellow.

Three New Deep-sea Fish Seen from the Bathysphere*

William Beebe

On August 11, 1934, I made a descent in the bathysphere under the auspices of the National Geographic and the New York Zoological Societies. Mr. Otis Barton accompanied me and on the deck of the *Ready* from which we made our dive, was my staff, John Tee-Van in charge of deck machinery, Gloria Hollister, recording my observations at the telephone, and Jocelyn Crane responsible for exact time and depths.

It was Dive Number Thirty and we submerged at 9:41 A. M., six and a half miles south by east of Nonsuch Island, Bermuda. The exact position was 32° 14′ 40″ No. Lat. and 64° 36′ 40″ West Long. This was well within the eight mile radius of work of all six years of my oceanographic researches in this region. We reached a maximum depth of 2,510 feet and were sealed up in the bathysphere for the duration of three hours and ten minutes.

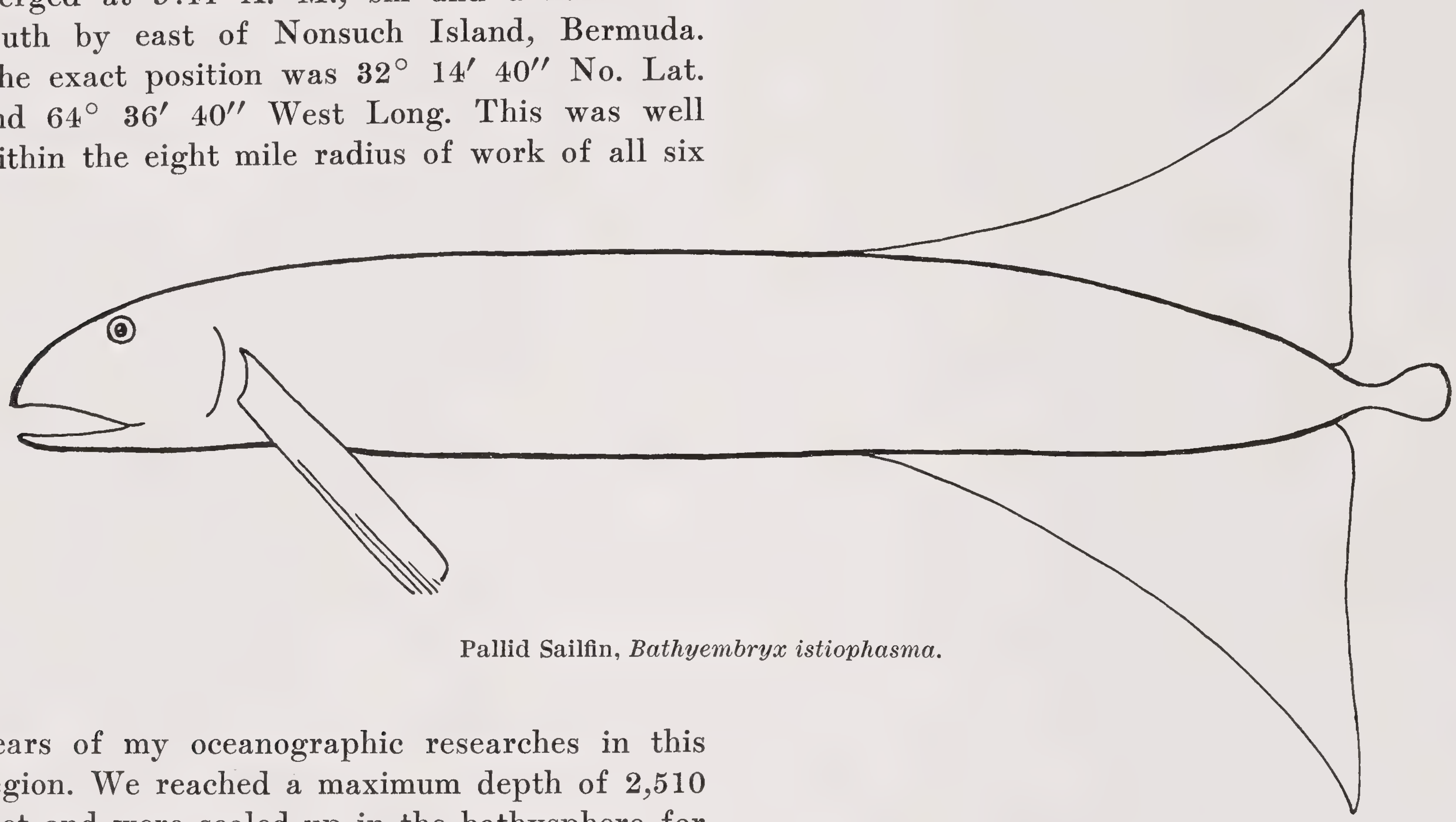
It will be recalled that on Dive Number Twenty in 1932 I was able to make detailed observations on a pair of fish six feet in length at a depth of 2,100 feet. Locating them near the family Melanostomiatidae, I gave them the name *Bathysphaera intacta* (Bulletin of the New York Zoological Society, Vol. XXXV, No. 5, pp. 175-176.)

On the present dive, Number Thirty, we had the good fortune to observe three new fish so clearly and for such an appreciable length of time, that I shall again chance the accusation of proposing for them *nomina nuda.* I have only our recorded observations, very carefully prepared outline drawings, and colored paintings for evidence, but in lieu of physical types I feel the unusual conditions and possible future, continued explorations warrant the definite establishment of these few fish.

Bathyembryx istiophasma gen. et sp. nov.

Seen from window of bathysphere, August 11th, 1934, six and a half miles south by east of Nonsuch Island, Bermuda, at a depth of 1,500 and again at 2,500 feet. The fish first became visible when I turned on the powerful electric light at the starboard window. Its body was half in, half out of the light, and it showed no fright, nor indeed of consciousness of the unusual illumination. I could see the shaded anterior half of the fish by the reflected light in the rich blue penumbra of the beam.

It was at least two feet in length, wholly without lights or luminosity; the body rather elongate, the sides almost parallel in lateral profile, tapering slowly to the tail, and with a very abrupt downward curve to the anterior profile of the head; the depth was not great,



Pallid Sailfin, *Bathyembryx istiophasma.*

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* Contribution, New York Zoological Society, Department of Tropical Research, No. 461. Published November 20, 1934.

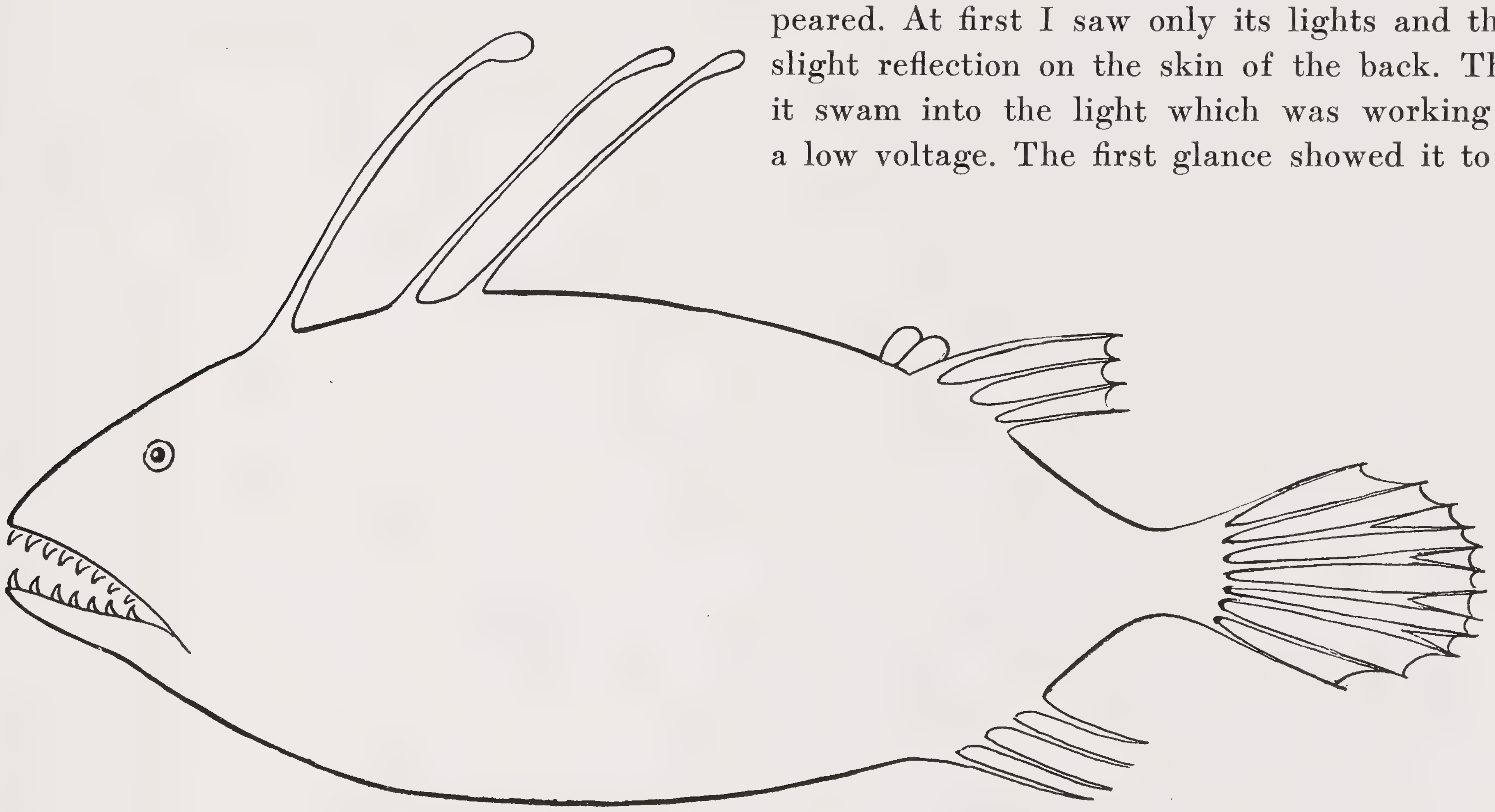
about six or seven in the length; the eyes were near the dorsal profile, small but not degenerate; the mouth horizontal and fairly large, the gape extending below or back of the eye; no teeth were observed; the pectoral fins long, at least twice the length of the mouth, apparently rather soft, if not filamentous, broad, and abruptly rounded at the tips. The color was peculiar, an unpleasant, pale, olive drab, like water-soaked flesh, an unhealthy-looking buff.

The vertical fins were alike and very large and sail-like, arising on the second third of the fish and lengthening rapidly in a concave curve high above and far below the body. Posteriorly they were truncated and described a sharp, vertical line from the extreme height, ending on the peduncle, close to the origin of the caudal. The latter fin was very small, decidedly degenerate, a small, rounded button, evidently of very little functional value.

During all the time the fish was in sight, the tall sail-like fins were in slight, but constant movement. These fins were either fleshy, or at least opaque, for I could distinguish no hint of rays.

At 2,500 feet, with the light full on, as I was getting ready to hold Mr. Barton's camera for a possible exposure, I had a distinct if brief glimpse of a fish which came down the light, head on. When it turned quickly, I saw that it was the same, or another individual *Bathyembryx,* or Pallid Sailfin as we may call it.

Taking all the characters into consideration, I should place this fish in or near the family Cetomimidae, although it is a very distinct form. The characters of the species may be taken as those of the genus.



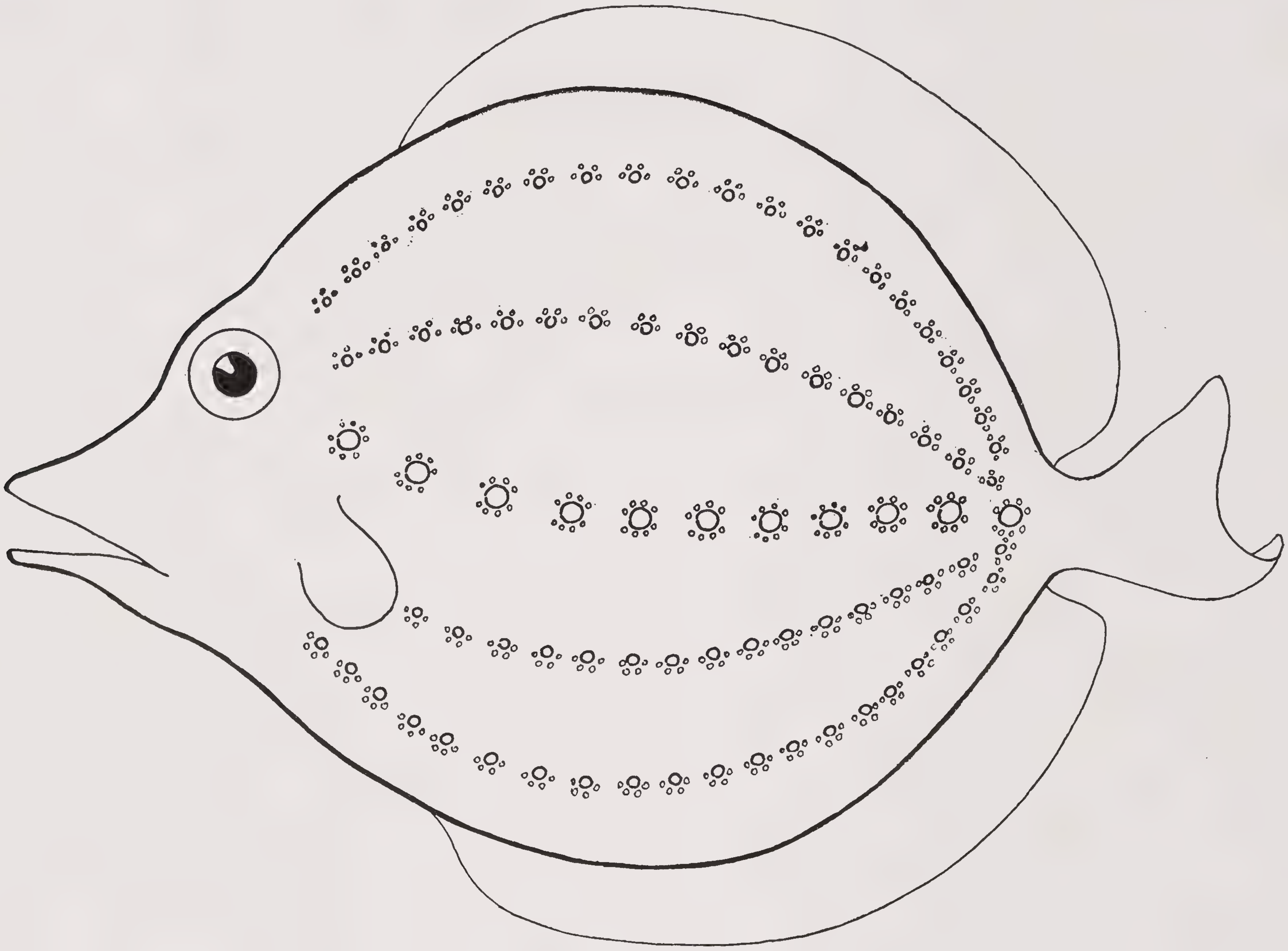
Three-starred Anglerfish, *Bathyceratias trilychnus.*

Bathyceratias trilychnus gen. et sp. nov.

The data of observation exactly as in the preceding species, except that the fish was seen at a depth of 2,470 feet. We had reached an extreme level of 2,510 feet and had begun our ascent to the surface. The cutting of a tie rope delayed us for a short time, when this fish appeared. At first I saw only its lights and their slight reflection on the skin of the back. Then it swam into the light which was working at a low voltage. The first glance showed it to be close to *Ceratias* and *Cryptosparas,* perhaps somewhat closer to the last, but with trenchant characters separating it from both.

It was six inches or a little longer in length, a deep, almost regular oval in outline, black and with small eyes. Paired fins were not seen, but pectorals at least were undoubtedly present. The remainder of the webbed fins were typical for this group, dorsal four, and anal four. But close in front of the dorsal were two oval, sessile bulbs like those of *Cryptosparas.*

Half-way between the bulbs and the eye was the posterior of three tall illicia, slender, apparently stiff, each about one-third the length of the fish. The anterior one originated almost half-way between the second and the eye, the two posterior ones arising closer together. The anterior was somewhat stouter but of the same length as the others. Each had a slightly enlarged tip. These tips gave out a strong, pale yellow light, powerful enough to illumine the adjacent, dorsal skin when the fish was not in the direct path of my beam. The most distinct character was the mouth, which was only slightly oblique and furnished with short, even, sharp teeth, these characters setting it well apart from all known genera of Ceratiidae. This Three-starred Anglerfish remained in full view, in the darkness and in the light, for fully five seconds, long enough for me to see and fix in mind the recorded proportions and characters.



Five-lined Constellationfish, *Bathysidus pentagrammus.*

Bathysidus pentagrammus gen. et sp. nov.

Again the observational data is the same for this as for *Bathyembryx,* with a change in depth to 1,900 feet. On the way to the surface, 470 feet higher than where we had seen *Bathyceratias,* this fish, one of the most unexpected and most gorgeous deep-sea inhabitants I have ever seen, appeared, quite as abruptly as the preceding. This too I saw both in the dark and in our light, thus showing almost all its principal characters. It swam slowly past and then turned broadside on, very close to the sharp boundary of the beam.

At the surface it would have passed for a strange *Chaetodon* or *Acanthurus,* but it was assuredly far from being either, unless a distant relation wholly adapted for life at three hundred fathoms. It was almost round—I estimated about five by six inches—with long, moderately high, continuous, vertical fins and a deeply concave tail, all exactly like the fins of *Acanthurus.* The eye was very large and interrupted the dorsal, cephalic profile. The mouth was large, the jaws projecting. The teeth and the pelvic fins were invisible to me, if any were present. The pectorals were rounded and rather short.

The bathysphere swung a few degrees to starboard and left the fish in absolute darkness, and I suddenly saw the amazing beauty of the photophores. There were five rows of these, one along the median line from the eye to the peduncle. Two others divided the upper half of the body into unequal thirds, curving downward along their whole length, and two more occupied the same relative positions below the center line.

The equatorial line consisted of larger lights than in the other four lines. The chief light in each of the numerous units was a bright, but pale yellow, shining from a large central photophore. Each of these in turn was surrounded with a circle in the median row, or a half circle in all the other rows, of tiny, brilliant purple lights. This formed a wonderfully beautiful pattern of illumination, resembling that of no other abyssal fish I have ever seen.

Before it left, it turned and faced me, its movement being perfectly distinct, even in the darkness, from the shifting of the lines of lights and their gradual foreshortening. I now saw that the breadth of the fish was not great, again about as in a surgeon-fish. Even in the partly front view, the sides were distinctly lighted by a soft reflection from the photophores.

I can assign this fish to no known family, but the Five-lined Constellation-fish assuredly deserves a name, pending the time when, with improved trawling nets, we will be able to bring one to the surface, alive or dead, and by dissection allot it more definitely to some known or unknown group.

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Courtesies of 1934

THE courtesy and kindness of a multitude of friends encouraged us from the inception to the end of our adventure during the present year. The actual dives of 1934 have been made possible by a grant from the National Geographic Society. Further contributions are from Childs Frick, Herbert L. Satterlee, Irving Taylor, Ogden Mills, C. W. Wickersham, John B. Clark, William A. Read, Silas W. Howland, Sidney A. Mitchell, Edwin S. S. Sunderland, Edward W. Mallinckrodt, Jr., Danforth Miller, Charles A. Marshall, Auguste Richard, Newbold L. Herrick, Robert P. Bass.

Dr. Gilbert Grosvenor, President of the National Geographic Society, was most considerate in the details of his offer of making possible the 1934 dives. He demanded no condition of a new record, which is why I gave it to him. Mr. E. John Long of the Geographic Society's staff, spent many weeks with us, a welcome guest who took full charge of the publicity, thereby relieving us of a most onerous task. Permission has kindly been granted to use duplicate electros of five colored plates which have appeared in the National Geographic Magazine.

Mrs. Else Bostelmann gave of her best in the colored paintings of deep-sea creatures, and when there is only my memory to assist and check, the artist must indeed be good. George Swanson was of constant help with sketches and pen-and-ink drawings. Perkins Bass and William Ramsey, just out of Dartmouth, made places for themselves and filled them worthily, saving us no end of time and lightening the thousand and one details which are never considered in any prevision of an undertaking such as this.

The Air Reduction Company designed and made for us new types of oxygen tanks and valves, an electric blower and four copper and brass trays for chemicals, and provided for six hundred feet of hose cable; the Bell Telephone Company in exchange for our old ear-phones, which they wanted for their museum, gave us three sets of their latest models of telephone outfits; the General Electric Company, through Mr. Gerard Swope, had three, new, fused quartz windows made to replace the old ones which had degenerated, and broke under dangerously low pressure tests.

The Watson-Stillman Company, thanks to Mr. E. A. Stillman, overhauled the bathysphere, replacing all worn-out parts, and fitted the new windows in place, so perfectly that not a drop of water entered. The Julien P. Friez Company loaned us one of their automatic temperature-humidity recorders, enabling us to use our eyes every moment for invaluable observation.

"But Dr. Beebe? Where is he?"
Courtesy of *The New Yorker.*

The Burroughs Wellcome Laboratory provided a complete medical outfit, and elaborate first-aid kits.

Others who have our gratitude for gifts of uncommon usefulness are: William Delano for our launch the *Skink,* Vivian Drake for a winch and wire, J. A. Roebling for miles of trawling wire, Maurice Ricker for the invention and construction of a stop motion picture camera, L. R. Smith for the first successful deep-sea pressure gauge, Siebe, Gorman for a complete diving suit, Herbert Satterlee for a binocular telescope, and for two refrigerators which have kept alive some of our most amazing abyssal fish.

The Furness Line granted our usual low rates and took especial care of the bathysphere in transit. In Bermuda, Dr. E. G. Conklin allowed us to board at the Biological Station, where for six months we were comfortably lodged and fed, only seven minutes away from our laboratory at New Nonsuch.

Commander Moorehead of the Meteorological Station, put all his knowledge and the daily weather reports at our disposal, and aided our selection of propitious days for the dives. The Bermuda and Halifax Cable Company through Mr. Rickwood, took care of all our messages at press rates, and in addition generously allowed one of their experts Mr. A. P. Skinner, to splice the new six hundred foot hose cable on to the old, making a perfect connection. Mr. Thatcher Adams and Robert Hartley caught many interesting specimens for us.

Hon. William E. Meyer let us have the *Ready,* the *Powerful* and the *Gladisfen* for our work. W. R. Perinchief oversaw all the host of details of machinery installation, and Captain James Sylvester for the third year, spent a worried month, responsible for the capable working of the crew of the *Ready,* the efficient interdigitation of the boilers and winches, and especially the smooth running out and in of the main steel cable itself, once almost off the drum, and down to three thousand and twenty-eight feet.

THE FLIES OF KARTABO

William Beebe

IT IS a matter for satisfaction on the part of the Director and Staff of this Department of the Zoological Society that not only is the present scientific work being carried on, and little by little, brought to completion, but the collections and investigations of as many as twenty years ago are still in course of active study.

The most recent proof of this is a paper which has just appeared in the BULLETIN of the American Museum. It is by Dr. C. H. Curran and is entitled "The Diptera of Kartabo, Bartica District, British Guiana." Although our interests in those days at the Zoological Society's station at Kartabo, were chiefly with the vertebrates, yet we neglected no opportunity to collect and study other forms of life. Flies are abundant and conspicuous in tropical jungles and exhibit most amazing courtships and other interesting phases of their lives, which are very little known.

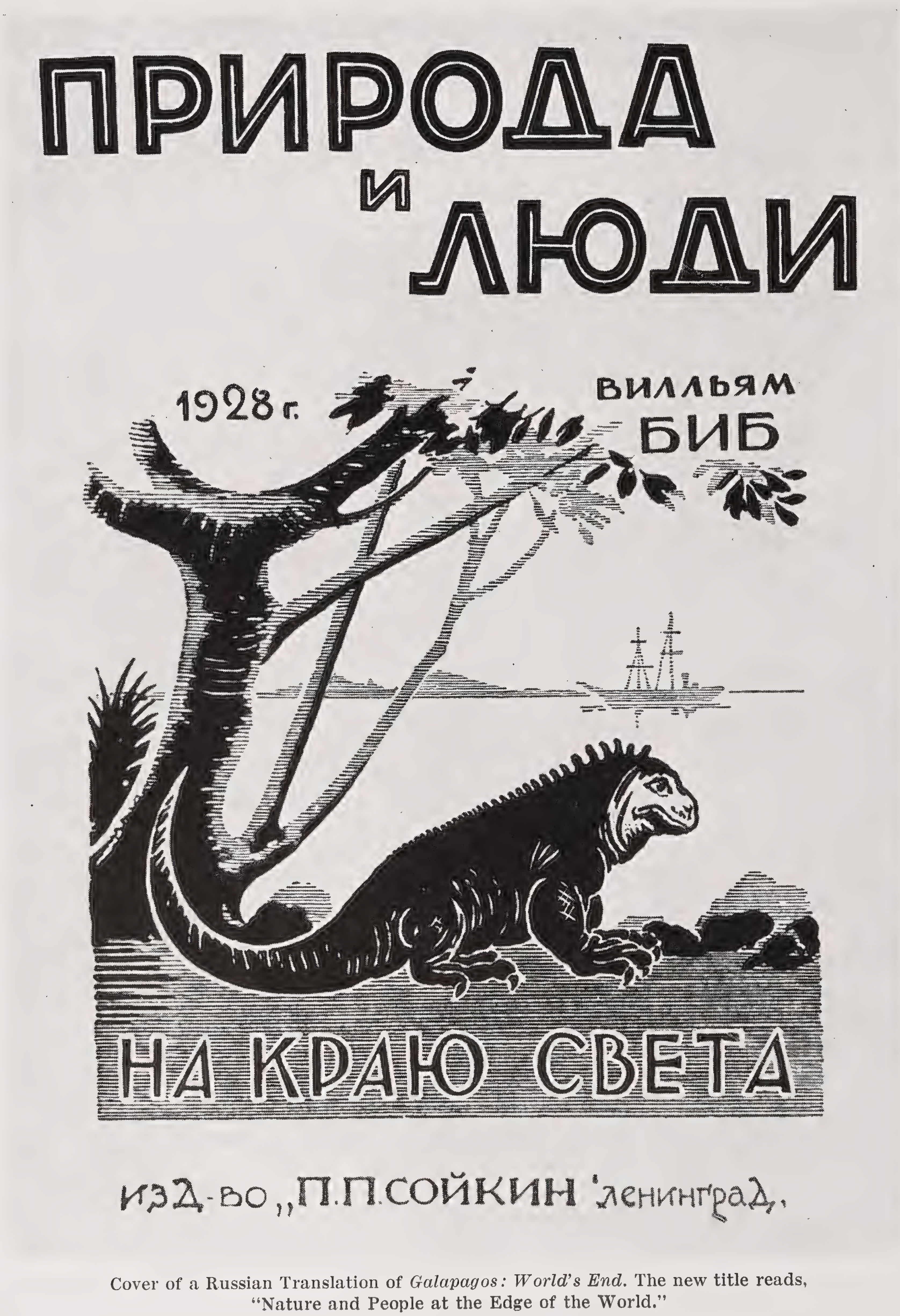
We gathered many hundreds of specimens of flies in Guiana between the years 1916 and 1924 and these have now been thoroughly studied by Dr. Curran and form the subject of this present paper which occupies 236 pages and 8 plates. In the Zoological Society's collection there have proved to be representatives of 38 families and no fewer than 420 species. Of these, 396 were collected by us at Kartabo, the station under intensive observation, an area which comprised only a quarter of a square mile. The remaining 24 species were taken within the surrounding six-mile radius of Bartica District. One hundred and twenty-three species are here described as new to science.

After a short introduction, Dr. Curran presents as Part I a list of the species, while Part II is the Systematic Account with, first, a key to the families. Throughout the succeeding treatment are descriptions of new species, notes on old ones, together with keys to genera and species. The account begins with the Crane Flies, *Tipulidae,* and ends with the curious family *Streblidae,* the members of which are found only in the fur of bats. The *Tabanidae* or horse flies will be reported upon later. Certain of the groups have been determined by Doctors Alexander, Bequaert, Walley, Bromley and Cresson. The types of new species have been presented by the Zoological Society to the American Museum.

The paper is not only of great value in itself, but the identifications have liberated for publication a host of notes on life histories which we made through past years, and which up to the present have been catalogued only under field numbers. Dr. Curran has done an excellent piece of work and the thanks of the Zoological Society are due him for the determination of this collection. The paper is Number 453 of the Contributions of the Department of Tropical Research of the New York Zoological Society.

ANNUAL MEETING

At the next annual meeting of the New York Zoological Society on January 8th, 1935, the department of Tropical Research will show a short film of the half mile dive, some of the new deep-sea fish observed, and a motion picture record of the complete development of a giant deep-sea eel in the egg, from a very early stage to the final hatching.



Cover of a Russian Translation of *Galapagos: World's End.* The new title reads, "Nature and People at the Edge of the World."

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-six volumes completed. Volume XXXVII in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Present Day Mammals (Leister); 74 pp. 105 ills.
Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
Sea Shore Life (Mayer). *Out of print.*
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend). *Out of print.*
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger). *Out of print.*
Gaff-topsail Catfish (Gudger). *Out of print.*
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
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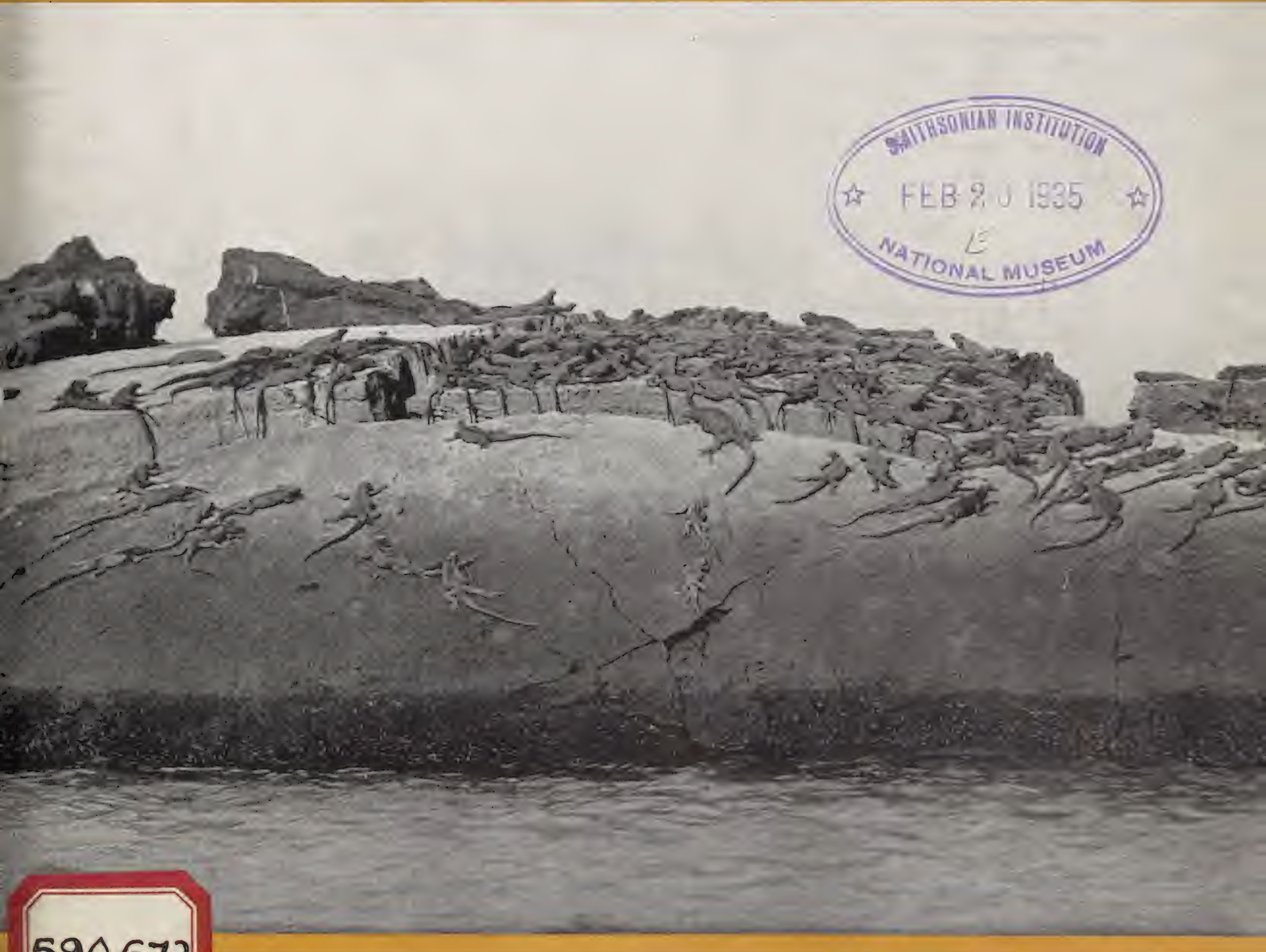

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Sea Iguanas on a Favorite Ledge at Webb Cove, Albemarle Island .... *Cover*
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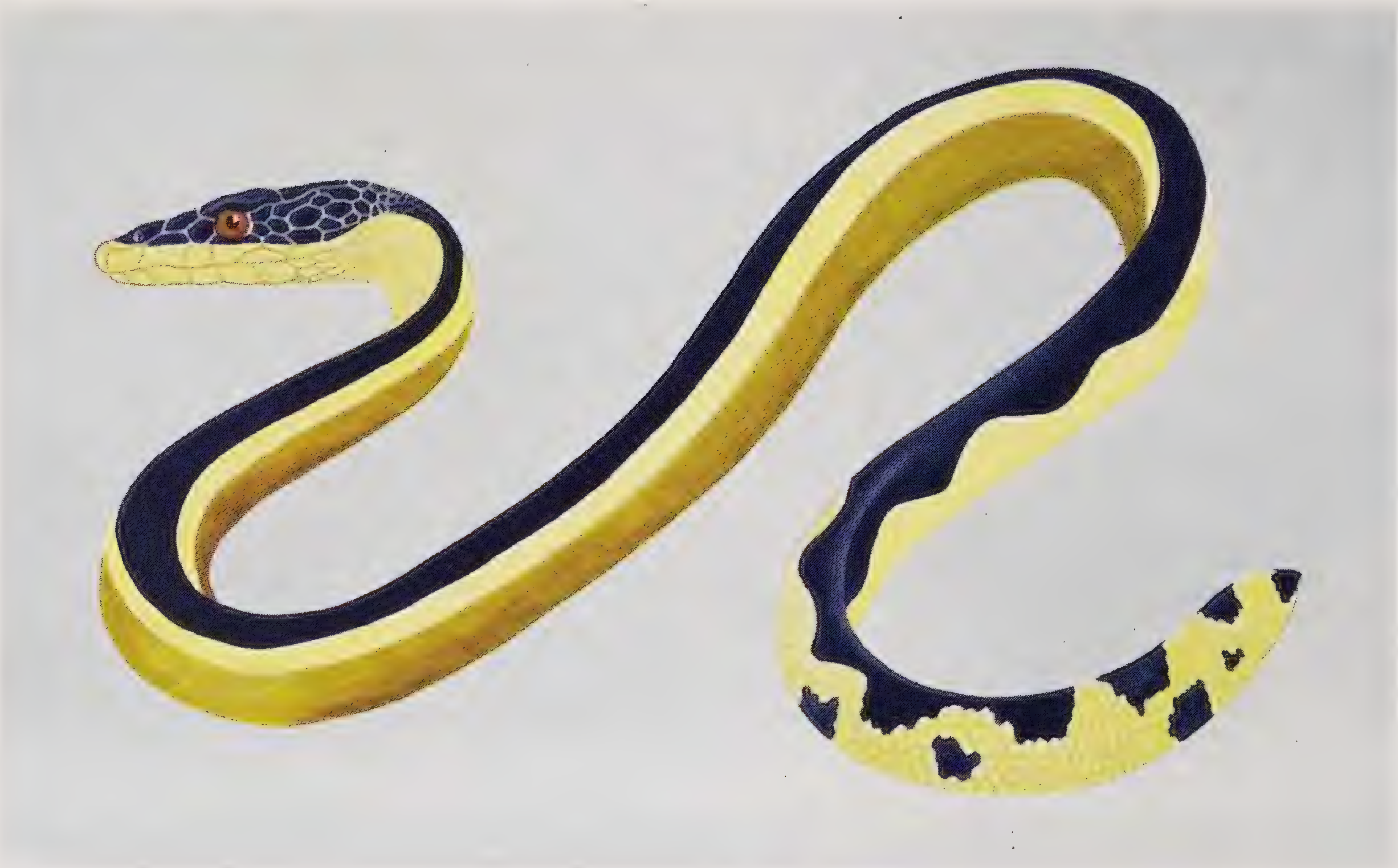
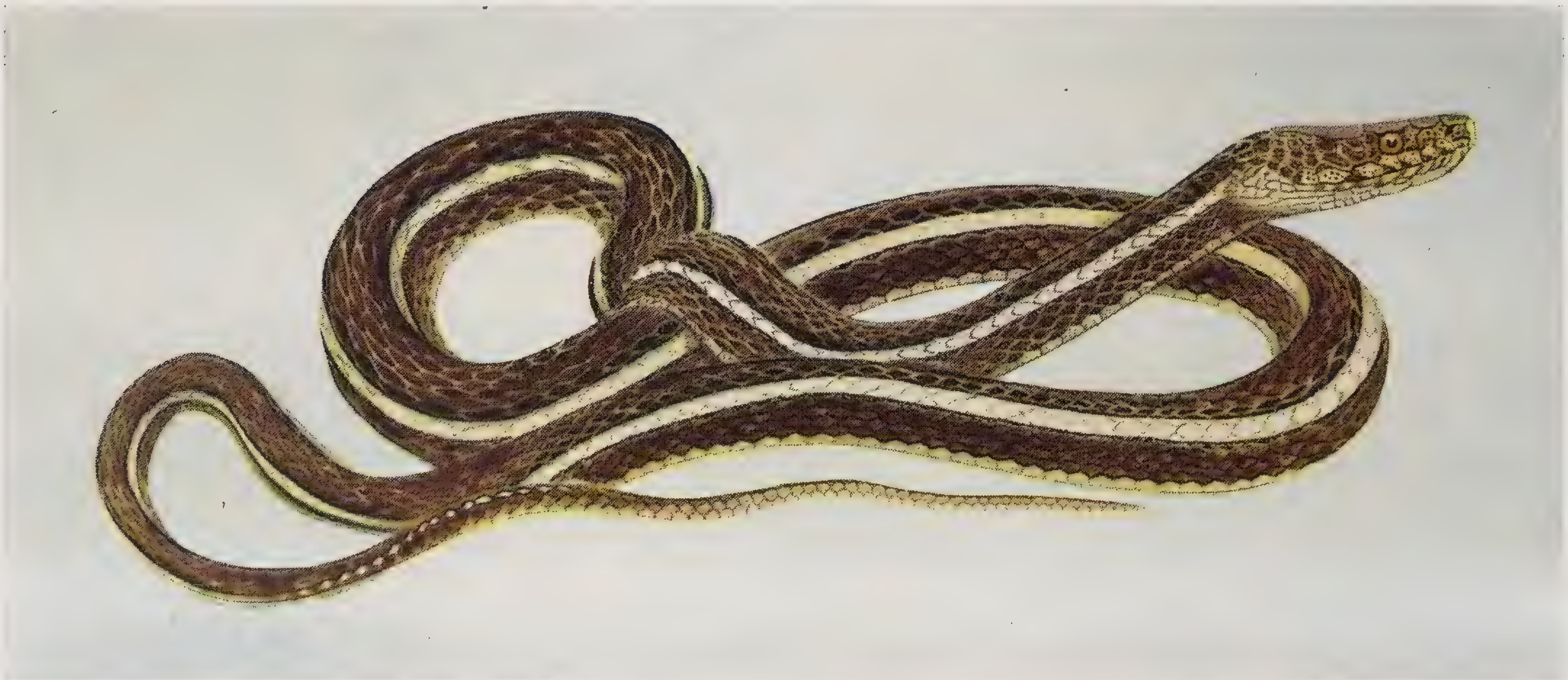


The Yellow-Bellied Sea Snake *(Pelamis platurus)* Found in Galápagos Waters Is the Most Widely Distributed Salt Water Snake and Has a Broad Range in Tropic Seas. Human Deaths from Its Bite Have Been Reported.



The Land Snake *(Dromicus hoodensis)* Is One of the Seven Species of Terrestrial Snakes Found Only on the Galápagos Islands, Although the Genus Flourishes on the South American Mainland. All Are Non-Venomous. (Both Watercolors by William B. Hayden)

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An Account of the Reptiles Inhabiting the Galápagos Islands

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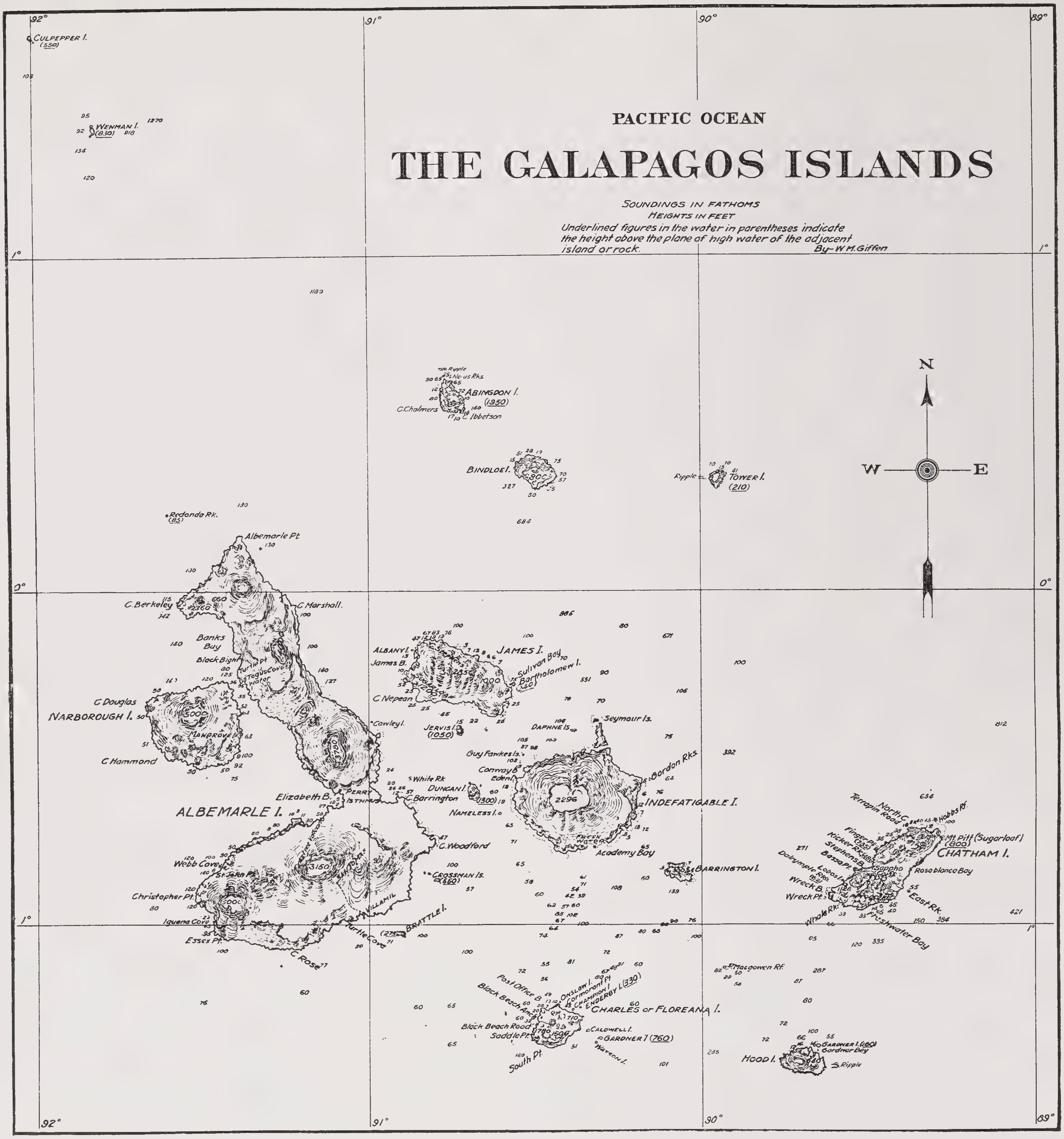
DURING the past few years the Galápagos islands have become a point of particular interest to some of those who were fortunate enough to be able to visit them in private yachts or in other vessels chartered for the purpose. No doubt that most interesting and well illustrated volume entitled "Galápagos: World's End," by Dr. William Beebe, was the primary cause which started several visitors on cruises to the islands, although for a hundred years they had claimed the attention of some of the world's most famous naturalists.

The author is indebted to his friend, Captain G. Allan Hancock, for the privilege of making his second voyage to the Galápagos on board the steamship *Oaxaca* in 1927 and 1928. The first was made as a member of the expedition of the California Academy of Sciences in 1905 and 1906.

Situated on the Equator about 600 miles West of Ecuador, to which country it belongs, the Galápagos archipelago extends from Latitude 1° 40′ North to 1° 30′ South and from Longitude 89° West to 92° West. Of the six principal islands, Albemarle, the largest of the group, is about 75 miles long and about 45 miles wide at the widest part. Nine smaller islands and many islets, many of them mere rocks, make up the remainder of the archipelago. All of the islands are volcanic, the larger ones having mountain peaks from 1,000 to 4,000 feet high. Many of these peaks have perfectly formed craters and that of Villamil mountain is about six miles in diameter.

The Galápagos archipelago, although it does not support a reptile fauna as varied and abundant as many other parts of the globe, even the nearest point of the adjacent mainland, has a most interesting and unique one. The most striking reptiles are the Giant Land Tortoise, the first account of which we owe to Dampier in his "New Voyage Around the World," published in 1697, and the Marine Iguana, solely dependent on the ocean for its food and found nowhere else in the world. The Galápagos Land Iguana, still found on some of the islands, always attracts the attention of visitors and no doubt is next in point of interest. In order that future visitors, lacking the various and scattered works dealing with the herpetology of the archipelago, may enjoy the convenience of a general account, the present paper treats of the various species in turn, gives an idea of their distribution and habits, and discusses what has caused them to become rare on certain islands and extinct on others.

The writer expresses his thanks to Captain Hancock and to Mr. Templeton Crocker for the original photographs from which several of the illustrations have been made, and for permission to publish them. The colored frontispiece is from watercolor paintings by Mr. William B. Hayden.



"The Galápagos . . . A Point of Particular Interest . . ."

Giant Land Tortoises

Giant Land Tortoises probably made their appearance on the earth about the beginning of the Cenozoic period, the age of mammals, and reached their greatest stage of development in the Miocene. During the Miocene and Pliocene periods they were very widely distributed over the earth and were particularly abundant in what is now North America, their fossil remains being found in great numbers in the Miocene deposits of our Midwestern States. There is no doubt that some of the extinct tortoises were very much larger than any living today. The plaster restoration made from the fossil bones of *Testudo atlas,* a tortoise found in the Lower Pliocene beds of the Siwalik hills in India, is in

Tagus Cove at Albemarle Island and the Oaxaca at Anchor. Sometime During the Formation of the Galápagos Archipelago, an Elevation of the Ocean Bottom Appears to Have Taken Place. Here at Tagus Cove, Characteristic Cavities Made by Sea Urchins Were Found Several Hundred Feet Above Sea Level. (Photo by George Stone)

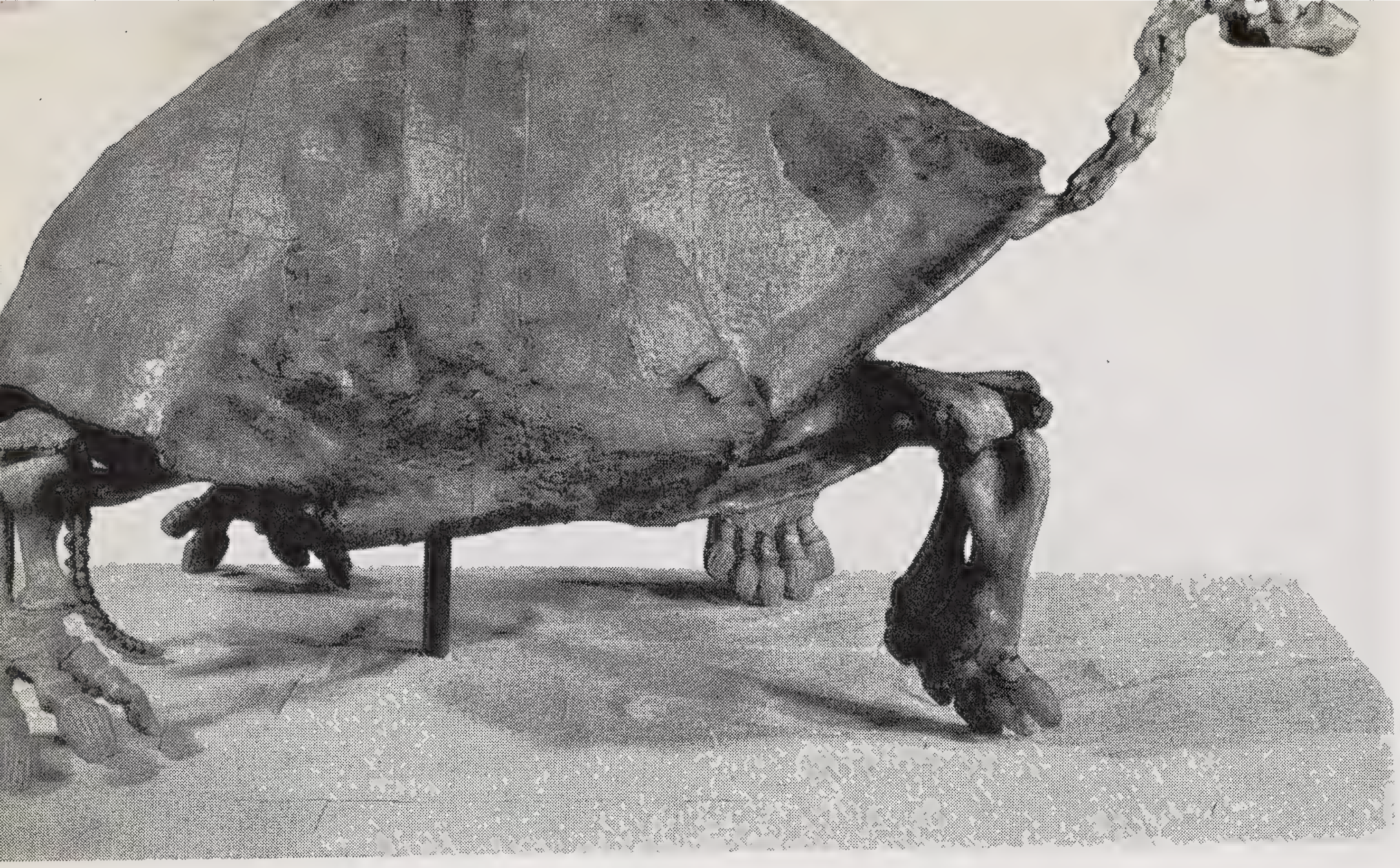
the Government Museum at Melbourne, Australia, and measures eight feet in length. Although this may not be accurate, on account of the bones of several specimens being used, those from which it was made leave no doubt as to the immense size of some of these extinct tortoises.

Besides the Galápagos archipelago, the only other places where Giant Land Tortoises have been found living are the islands off Southeast Africa, which include the Mascarene islands, the Aldabra-Madagascar group, and the Seychelles. All of these tortoises belong to the genus *Testudo,* the same as that which inhabits the Galápagos.

The tortoises of the African islands were practically exterminated some hundred years ago owing to the inroads made upon them by the early voyagers who, like those visiting the Galápagos, used them for food. In 1737 the supply of tortoises was becoming exhausted on the island of Mauritius. In 1761 they were being taken off of Rodriguez and by 1770 were so thinned out that it became unprofitable to hunt them. With the exception of South Aldabra, which has very few tortoises left, the Galápagos islands now harbor the last members of the race in their natural or wild state.

What caused their near disappearance is not known but it may be that they were unable to adapt themselves to the changes taking place on the earth and, having small brain capacity, were ill-fitted to withstand the onslaught of the more active and intelligent mammals.

The Galápagos Tortoises—All the juvenile tortoises are similar in shape and it is not until mature individuals are placed side by side that the variations in the shape of the shell, which distinguish the several species, are noticeable. It was Captain David Porter of the U. S. Frigate *Essex* who first called attention to the fact that differences existed between the tortoises of the several islands. In his "Journal of a Cruise Made to the Pacific Ocean" (New York, 1822), Porter states: "Those of James



A Giant of Long Ago—A Fossil Land Tortoise *(Colossochelys atlas)* Found in the Pleistocene Beds of the Siwalik Hills of Northern India. Its Shell Is 7 Feet, 4 Inches Long Over the Curve. (Photo from the American Museum of Natural History)

island appear to be a species entirely distinct from those of Hood and Charles islands. The form of the shell of the latter is elongated, turning up forward in the manner of a Spanish saddle, of a brown color and of considerable thickness. They are very disagreeable to the sight, but far superior to those of James island in point of fatness, and their livers are considered the greatest delicacy. Those of James island are round, plump, and black as ebony, some of them handsome to the eye, but their liver is black, hard when cooked, and the flesh altogether not so highly esteemed as the others."

A study of the various species has resulted in their being divided into the following races:

The Saddle-backed Races	Island
Testudo abingdoni	Abingdon
phantastica	Narborough
becki	Albemarle (North)
ephippium	Duncan
hoodensis	Hood
elephantopus	Charles

The Intermediate Races	
Testudo darwini	James
chathamensis	Chatham
microphyes	Albemarle (Tagus Cove)
güntheri	Albemarle (Southeast)
vicina	Albemarle (South)
wallacei	Jervis

The Dome-shaped Races	
Testudo porteri	Indefatigable
vandenburghi	Albemarle (Cowley Mountain)

The saddle-backed tortoises have longer necks and legs and the concave plastron of the males is much more pronounced than in the non-saddle-backed races. Another peculiarity of the saddle-backed races which is characteristic of only one other species of Galápagos tortoise, *Testudo güntheri,* one of the intermediate races from Southeast Albemarle, is that the adult males have the posterior extremity of the plastron terminating in thick, knob-like processes. In *Testudo güntheri* both the male and the female possess these processes. In all of the races the adult males can readily be distinguished from the females by the concavity of the posterior portion of the plastron and the greater length of the tail.

The general coloration of the shell and limbs of all of the Galápagos tortoises is black, the males of the saddle-backed races having the throat and lower jaw marked with yellow.

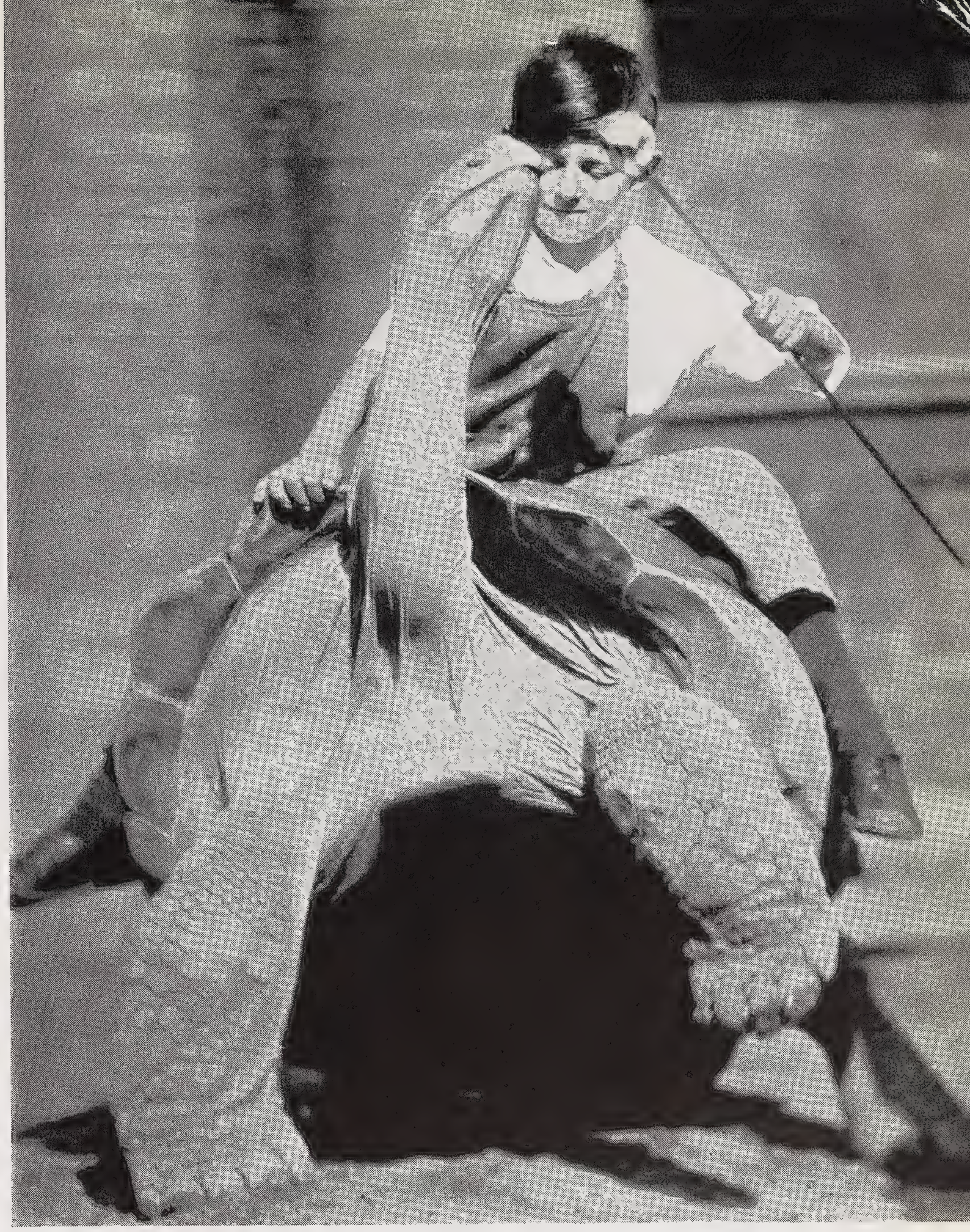
Large male tortoises have been known to weigh more than 500 pounds. Lord Rothschild records a male tortoise in his collection at Tring

On the Morning of December 27, 1927, While the Author Was Returning from the Galápagos Aboard the Oaxaca, a Landing Was Made on Malpelo Island —the First Landing, As Far As the Records Show, Since that of the Spanish Commodore Malaspina in 1789. (Photo by George Stone)

as having weighed 593 pounds, but of course this is an exception. A Galápagos tortoise taken in June, 1899, and kept at Riverside, California, until April, 1914, when it died from exposure on wet ground, weighed 415 pounds at the time of its death. In seven years it increased in weight from 29 to 350 pounds. The weight of the average sized large male is probably about 300 pounds.

It is a well known fact that tortoises are long-lived animals, and if certain suppositions concerning what is known as Marion's tortoise are correct, there is evidence that a tortoise lived 152 years. Captain Parsfield Oliver, who made a study of the history of the Mascarene islands, believes that a tortoise which died on the island of Mauritius in 1918 was one of the original tortoises taken there in 1766 by the French explorer, Marion de Fresne. Lord Rothschild records an individual, whose history he has traced, as "an exceedingly old animal, at least 300 years."

Habits of the Giant Land Tortoises—On the islands such as Albemarle and Indefatigable, which have mountain peaks some 3,000 feet high, the land tortoise is found more abundantly at the higher elevations (about 2,500 feet), where the fog hangs over the green zone and ferns, trees, vines, and grass grow in abundance. Darwin in his "Journal of Researches" (New York, 1902) says: "Those which frequent the higher and damp regions eat the leaves of various trees, a kind of berry (called guayavita) which is acid and austere, and likewise a pale green filamentous lichen (Usnera plicata), that hangs in tresses from the boughs of the trees." Villamil mountain is typical tortoise country, where the open grass land has scattered patches of trees and bushes, with numerous puddles formed by the rains. In certain types of country, such as at Iguana Cove mountain, the vegetation extends to the water's edge and here tortoises may be found among the trees and heavy growth of cactus. By constant traveling up and down the mountain they have worn trails which are easily distinguishable even by persons inexperienced in tortoise hunting.

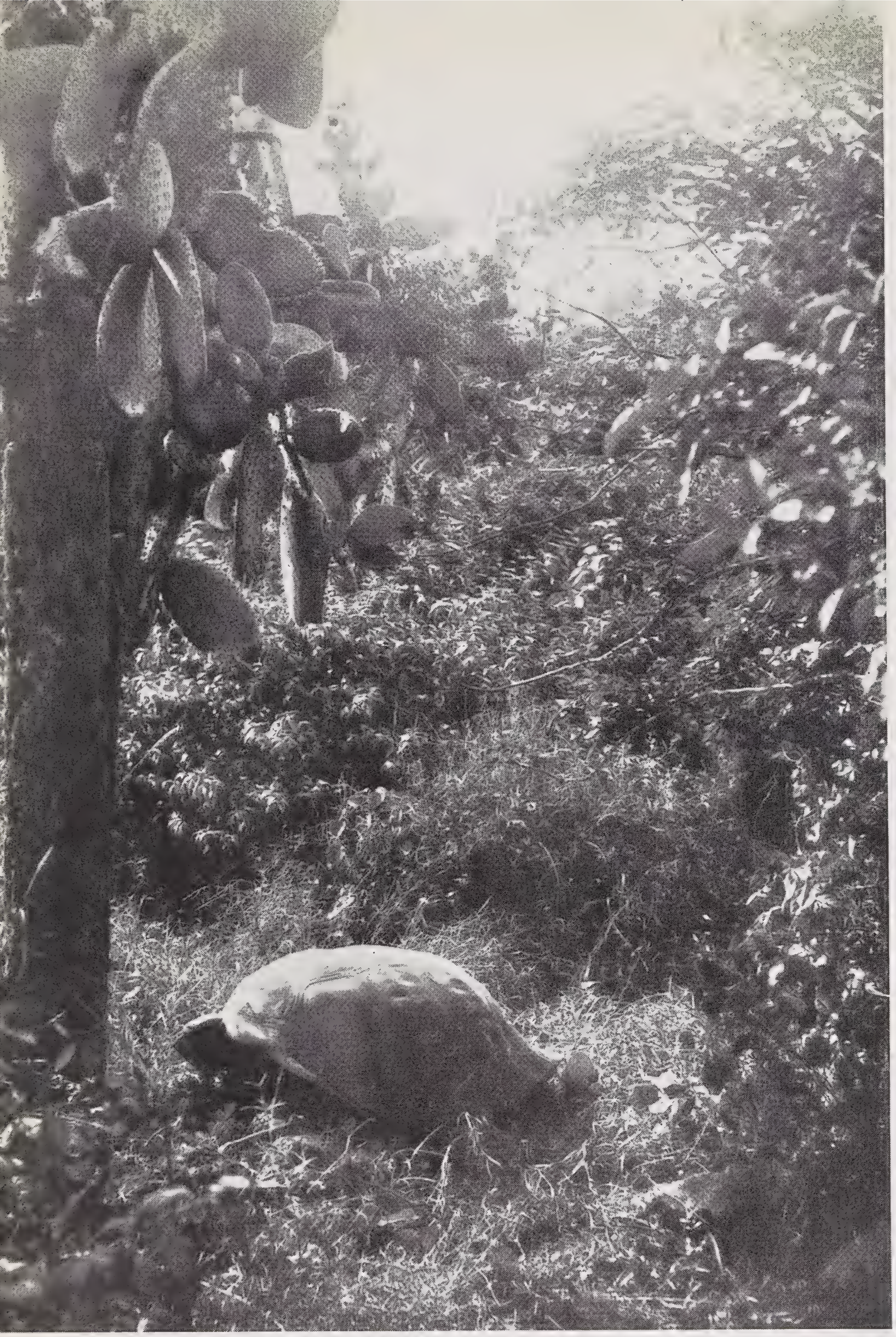


And a Giant of These Days—A Galápagos Tortoise *(Testudo vicina)* from Albemarle Island. Thirty Years in the Zoological Park. It Is Probably the Largest in the United States. It Weighed 140 Pounds in 1904 and in Recent Years Has Not Added Much to Its Weight of 305 Pounds in 1929. The Shell Is 3 Feet, 10½ Inches Over the Curve.

The first sign to strike the eye of the hunter would probably be a tunnel through the underbrush. If the trail were old, or over ground without any partially buried lava boulders, the tunnel might be all that would betray the tortoise.

However, close observation generally can turn up fresh signs. Across or beside the tunnel, vines are likely to be stretched taut or snapped, leaves disturbed and turned to expose the undersurface, or marks of toenails scratched in the soft earth. A fresh cactus leaf partly eaten shows where the tortoise has been feeding, and a clearing of fresh earth close by the trail is a sign that it has been resting.

Some of the old trails that lead to waterholes have been used for so long that exposed lava



In Country of This Kind Around the Base of Iguana Cove Mountain on Albemarle Island, the Giant Land Tortoise May Be Found. Its Paths Through the Underbrush Are Full of Signs for the Tortoise Hunter. (Photo by R. H. Beck)

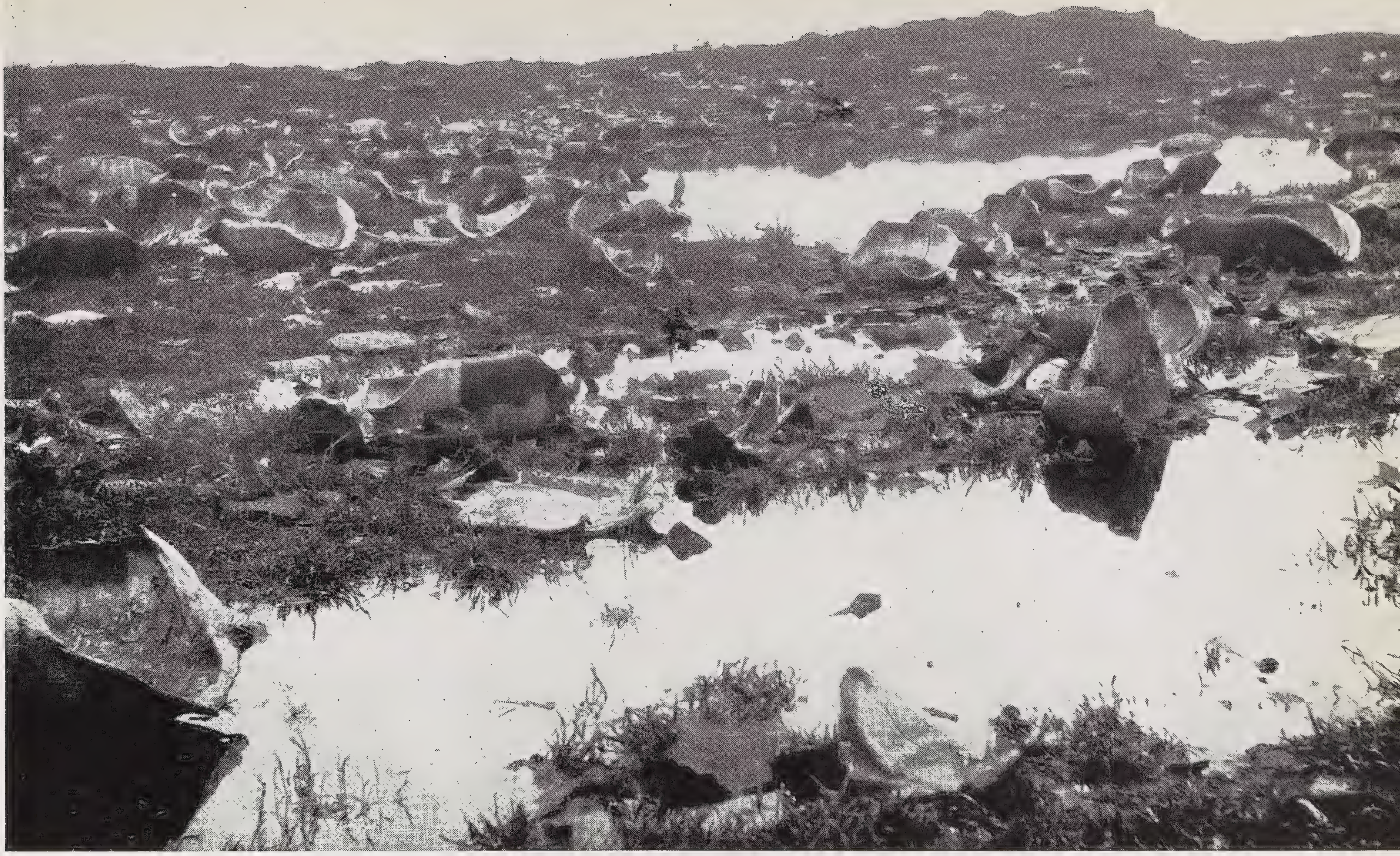
boulders have been worn smooth and almost polished by the dragging shells.

The land tortoise is fond of lying in pools of water, or in mudholes formed by the overflow of lagoons into the depressions back of the sand beaches. Here it may stay for hours at a time, or it may seek the shade of some protecting bush, dig out a slight hollow in the earth, and remain there during the heat of the day.

There seems to be no particular time in which tortoises travel about feeding, but on cool and cloudy days they are more active, especially after a rain. They are strictly vegetarian, the fresh leaves of the cacti being particularly acceptable. Besides the cacti, orchilla, a species of lichen, forms a major portion of their food, especially among the tortoises of Duncan island. The small apple-like fruit of the *Hippomene,* found commonly along the South Albemarle coast, is eaten by the tortoises in the vicinity of Cape Rose. Practically all species of grasses and vines found on the islands are readily eaten.

Although the land tortoise is fond of water and drinks great quantities when available, there are certain parts of the country where it is unable to get any for most of the year and it then must rely on the moisture from the leaves of the cacti and the dew on the orchilla and grass. It often happens during the rainy season that holes in the lava become filled with water and temporary lakes are formed where the water does not sink too rapidly into the porous soil, and it is then that the tortoise is able to drink its fill.

Again to quote Darwin, who has given the best account of the land tortoises ever written: "The tortoise is very fond of water, drinking large quantities and wallowing in the mud. The larger islands alone possess springs, and these are always situated toward the central parts, and at a considerable height. The tortoises, therefore, which frequent the lower districts, when thirsty, are obliged to travel from a long distance. Hence broad and well-beaten paths branch off in every direction from the wells down to the seacoast; and the Spaniards, by following them up, first discovered the watering-places. When I landed at Chatham island, I could not imagine what animal traveled so methodically along well-chosen tracks. Near the springs it was a curious spectacle to behold many of these huge creatures, one set eagerly traveling onward with outstretched necks, and another set returning after having drunk their fill. When the tortoise arrives at the spring, quite regardless of any spectator, he buries his head in the water above his eyes, and greedily swallows great mouthfuls, at the rate of about ten in a minute. The inhabi-



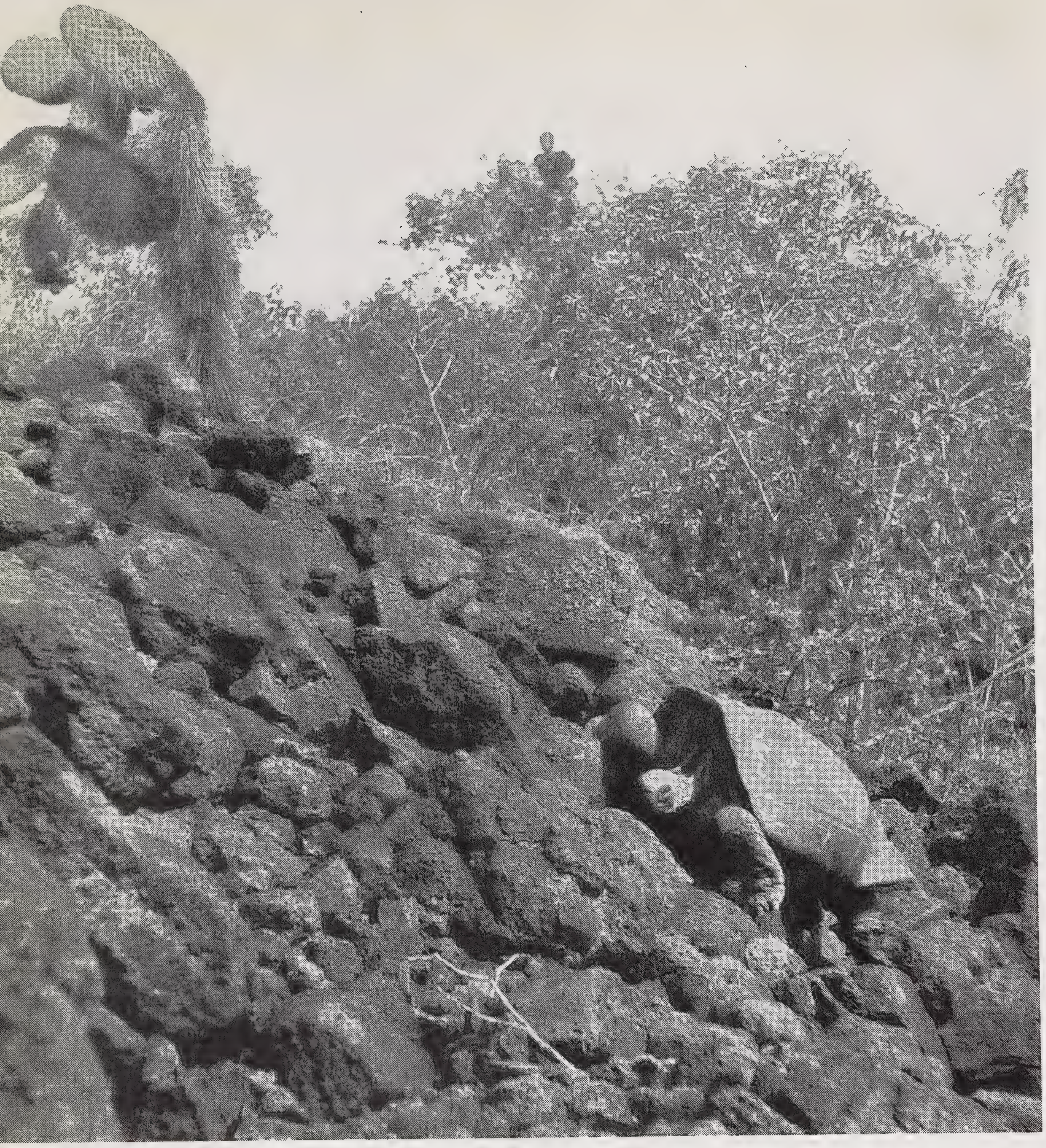
A Picture that Speaks for Itself and Tells Why the Giant Land Tortoise Has Become Extinct, or Almost Extinct, on Many Islands of the Galápagos. This Is an Abandoned Oil-Hunters' Camp on Albemarle, Photographed by R. H. Beck on the Expedition of the California Academy of Sciences to the Galápagos in 1905-1906.

tants say each animal stays three or four days in the neighborhood of the water, and then returns to the lower country; but they differed respecting the frequency of these visits. The animal probably regulates them according to the nature of the food on which it has lived. It is, however, certain that tortoises can subsist even on those islands where there is no other water than what falls during a few rainy days in the year.

"The tortoises when purposely moving toward any point travel by night and day, and arrive at their journey's end much sooner than would be expected. The inhabitants, from observing marked individuals, consider that they travel a distance of about eight miles in two or three days. One large tortoise, which I watched, walked at the rate of sixty yards in ten minutes, that is 360 yards in an hour, or four miles a day, allowing a little time for it to eat on the road."

The breeding season is in March and April. The males become quite active at this time, and make a hoarse bellowing noise which can be heard for a distance of about 300 yards. Considerable time elapses after mating before the eggs are laid, some that we found in November being perfectly fresh. The female digs a small hole in the soft earth, a little more than a foot in width, preferably along a cattle trail or at the edge of some opening where the sun will shine upon the spot for at least part of the day, and deposits her eggs in two or three tiers, each tier separated by a layer of earth an inch or two in thickness. The earth is left loose around the eggs, but when they are all covered the tortoise makes a hard crust, three or four inches deep, over the nest by turning about on the earth and packing it down by her own weight. The eggs are not all laid at once, but in two or three separate lots, judging from the varied development of eggs in females examined. Nests discovered and dug out contained from eight to seventeen. These are white, globular in shape, about the size of a billiard ball, and have a hard, porous shell.

In regard to the breeding habits of the tortoise, Darwin states: "During the breeding season, when the male and female are together, the male utters a hoarse roar or bellowing, which, it is said, can be heard at the distance of more than a hundred yards. The female never uses her voice, and the male only at these times; so



In Its Slow Way, the Giant Tortoise Travels Over Difficult Terrain. *Testudo ephippium* Günther Climbing a Lava Hill on Duncan Island. (Photo by John Tee-Van)

that when the people hear this noise they know that the two are together. They were at this time (October) laying their eggs. The female, where the soil is sandy, deposits them together, and covers them up with sand; but where the ground is rocky she drops them indiscriminately in any hole; Mr. Bynoe found seven placed in a fissure. The egg is white and spherical; one which I had measured was seven inches and three-eighths in circumference, and therefore larger than a hen's egg."

Causes which Led to the Extinction, or Near Extinction, of the Giant Land Tortoises—The Giant Land Tortoises, from which the archipelago gets its name, (*galápago* being the Spanish for tortoise), are all but extinct on most of the islands on which they have been found, and are extinct on some.

Of the various causes which led to this situation, the two most notable are the inroads made upon them by the whale ships of the early days, and later the slaughter by oil hunters. The captains of the whalers cruising about the islands found in the tortoises an excellent supply of fresh meat for their crews. Being easily kept on board ship, as they require neither food nor water for long periods of time, they furnished a constant supply of fresh meat, no doubt helping in a great way to make the whaling industry possible when ships made cruises of two to three years' duration. Dr. C. H. Townsend in his paper, "The Galápagos Tortoises in Their Relation to the Whaling Industry," (*Zoologica,* New York Zoological Society, 1925), records more than 10,000 tortoises taken off the islands between 1831 and 1868. These figures are taken from the logbooks of American whalers. When it is considered that the logs he examined represent only a part of the American whaling fleet and none of the British whalers, men-o'-war, or the buccaneers who frequented the islands, it can readily be seen that the slaughter was appalling.

Lieutenant J. Shillibeer, R.M., attached to HMS *Briton,* (Sir Thomas Stains, Captain, R. N., Commanding), spent ten days in the Galápagos in 1813 and made the following entries in his journal concerning the tortoises of Charles, Chatham, and James islands: "Charles island, July 25, 1813. We found but few tortoises and no water.

"Chatham island, July 26, 1813. Here we were fortunate in our search for tortoises, and took more than a hundred, among them were several weighing upwards of 370 pounds. Amongst the grass on the isthmus, we took some land tortoises. One of these creatures greatly exceeded the others in size, and as the progress this species makes in growing is particularly slow, I am led to conclude it to have been of great age. From its having been taken at this island, the sailors whimsically bestowed on it the name of Lord Chatham. It soon lost its natural shyness, became much petted among the crew, and latterly, was in regular attendance in the galley at the hour of meals, when it partook of the ship's allowance, and was fed by the men either out of their hands or some of their utensils, but notwithstanding, every care was taken, its life could not be preserved in the excessive cold, of a high southern latitude."

Of James island he said: "Land tortoises are found here in great abundance, whose meat being very fine, we found it a great relief from salt provisions."

In 1875 Commander Cookson of HMS *Peterel* reported that tortoises were extinct on Charles island, few survived on Chatham island, and that on Hood, James, and Indefatigable their numbers were so greatly reduced they were no longer hunted. He also reported them still abundant on the Southeast end of Albemarle and tolerably numerous at Tagus Cove, Albemarle island. According to the whalers' logbooks examined by Dr. Townsend, the last tortoises were taken off Charles island in 1837.

The oil hunters next claim attention and it is no doubt owing to them that the tortoises were all but exterminated. In the year 1835 Captain Fitzroy, of HMS *Beagle,* found a party camped on James island killing tortoises for the oil. In 1902 Mr. R. H. Beck, leader of the Academy's expedition of 1905-1906, found the oil hunters at work on Villamil mountain, southern Albemarle, where they had already made such great inroads on the tortoises that the skeletons around the waterholes showed that the larger ones were doomed. When the writer visited this locality in 1905, very few large tortoises were to be found. The simple equipment of the oil hunter—a few sacks, casks, and a boiling pot—enabled him to move rapidly from place to place and the extermination of the tortoises in a particular locality was only a matter of days or weeks.

We now come to the worst of the natural enemies of the tortoises: wild dogs and rats. Unfortunately, the early voyagers introduced dogs and rats onto the islands, and these animals have so greatly increased in numbers that they now present a real danger to the tortoises, the rats eating the young, which have just hatched from

Galápagos Vegetation Was Made for Tortoises and Iguanas and Not for Humans. A Sample from the Neighborhood of Conway Bay, Indefatigable Island. (Photo by John Tee-Van) the egg, and the dogs eating both these and fully grown individuals. The wild dogs have developed wonderfully strong jaws and, by catching hold of the edge of the shell, gradually bite off portions of the bone until the flesh is reached. Once an opening is made in the skin they literally eat the tortoise out of its shell. The chief sufferers from the dogs are the tortoises of Villamil mountain. It is encouraging, though, that when Dr. Townsend visited the Galápagos in 1928, on board the U. S. Fisheries Steamer *Albatross II,* about 180 small tortoises were taken off Villamil and from the immediate vicinity. These were brought to the United States, where they were distributed among various zoological gardens. A few were afterwards sent to Honolulu and to Sydney, Australia. The fact that on Villamil mountain there are many wild cattle, which are more easily killed than the tortoises, no doubt helps to protect the latter. It may be readily seen that between man and its natural enemies, the tortoise is hard pressed and its extinction sooner or later is inevitable.

Besides those killed for food, some were transplanted by the early navigators to other islands of the Pacific, where most of them perished. Amasa Delano, in 1818, carried 300 tortoises from James island to the island of Mas Afuera, where he landed half of them after having them sixty days aboard ship. Captain David Porter, of the *Essex,* carried a number to Rotumah island, where he distributed some among the chiefs and turned many others loose.

In the "Records of the Australian Museum" (Sydney, April 17, 1899), Mr. Edgar R. Waite gives a very interesting account of one of these tortoises. He says: "For particulars of the early history of this tortoise I am indebted to Miss Annie C. E. MacDonald. About the year 1866 it was given to her father, the late Alexander MacDonald, by King George of Tonga, and was what was called a chief's gift, that is, a gift supposed to pass between two great chiefs of equal standing. When taken to Tonga from Rotumah, the reptile caused a great sensation among the natives and was presented to Mr. MacDonald in recognition of his kindness to the King's son when in Sydney, both father and son having taken a violent fancy to the well-known trader.

"The tortoise was brought to Sydney in the schooner *Ida,* one of MacDonald's and Smith's whalers. Captain Howard, who was in command of the vessel, had known the tortoise for fifty years previously on the island of Rotumah, it having been landed there from the Galápagos islands by an American whaler[1] many years before. It was, within the memory of the inhabitants, always the same size.

"From 1866 to the end of 1896 the tortoise lived in Sydney, and at the latter date was removed to England, having been purchased, I understand, by Hon. Walter Rothschild for his menagerie at Tring."

According to the records of Lord Rothschild, this tortoise died in Regent's Park, London, in July, 1898.

Mr. Thomas G. Thrum, in the "Hawaiian Annual" for 1904, gives an account of two Giant Tortoises in Honolulu at that time, under the heading: "A Historic Tortoise or Land Turtle (*Testudo microphyes* Günther).

"There is cared for at Waikiki by an aged couple, retainers of the late Queen Dowager Kapiolani, a tortoise, or land turtle, of great age, of which the following brief history is gathered:

"The subject of this sketch was brought to these islands by Capt. John Meek from Kahiki, the natives say, on his arrival at these islands. This means from some unknown foreign land about the year 1812, but in actual fact it must have been a number of years later.

"Capt. Meek first touched at these islands as first officer of a vessel in the Northwest trade in 1880; then visited and sailed out of this port as master on trading voyages between Mexico and China from the year 1812, and became a resident of Honolulu in 1825.

"It is known that he brought a number of horses from the coast during these early voyages, and report says he brought cattle also, with many of these land turtles, which latter, very likely, were brought on one of his trips from Mexico. These were said to have been all kept on the Meek premises, on King Street, and attracted the attention of the Chiefs, foreigners, and common people. This fact would bring it to not earlier than 1825.

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[1] Evidently a mistake for the American frigate *Essex.*

"Upon their disposal, or distribution, this one was given by Captain Meek to King Kaukeouli, Kamehameha III. During the time the High Chief Paki was Chamberlain to the King, it was under his charge and cared for at his Aigupita premises, Ewa-wards of the new Young Hotel, on King Street.

"After the death of the King and of Paki, this tortoise became the property of B. Namakaeha, first husband of the late Kapiolani, and was taken to his premises at Kaalaa. At Namakaeha's death it was moved to Waikiki, where it has since been cared for by two old retainers from Paki's time. Upon the death of Kapiolani a few years ago, it naturally came into the possession of her new nephew, Prince David.

"There is another similar venerable-looking tortoise in Nuuanu Valley, owned by Mrs. M. E. Foster, which is said to have been brought here on a whaleship many years ago from the Gallipagos Islands, their natural habitat, but no further particulars can be gathered. These two are probably the only ones of their kind on the islands."

In May, 1915, Mr. Thomas Gerrard of London visited Honolulu and reported five tortoises living on the Hawaiian islands at that time. Two of these he secured for Lord Rothschild and shipped to England. The clerk of Public Parks at Honolulu reported that the last of the old tortoises in Kapiolani Park died in 1929, but was unable to give any information regarding the two remaining ones reported by Gerrard. I have been unable to find any trace of them through other sources, so it may be that they have since died.

Another Giant Tortoise was reported by Mr. Edward W. Gifford as living on the island of Tonga in 1921. His letter dated January 29, 1921, from Nukualofa gives the following information regarding it:

"There is a tortoise in Nukualofa known as Tui Malila (King of Malila). It is the property of the Queen. One story has it that Captain Cook presented it to the ruler of Tonga; another that King George I obtained it from a vessel which called in Haapai, probably in the first half of the last century. As Cook does not mention the presentation of a tortoise, I think the latter story is the more likely."

Concerning this tortoise, Sir Joseph Carruthers in his work on Captain Cook, (Captain James Cook, R.N.; 150 Years After. New York, 1930), says: "Although there is no mention of the matter in Cook's journals, there is, from Tongan sources, handed down from generation to generation, the tradition that Captain Cook left two tortoises at Haapai, one of the islands in the Tongan group, during one of his two visits there between 1774 and 1777. One of these still survives and is an honored guest in the grounds of the Royal Palace at Nukualofa, in the island of Tongatabu.

"There is no doubt about the tradition, which was committed to writing as soon as the natives were able to do so. I received a copy of this from the Rev. R. Page, chairman of the Tongan Wesleyan Mission, in 1927, when I first visited the Tongan islands. I then also met the Prince Consort, Tungi, the grandson of the Chief to whom Cook gave the two tortoises. At the royal palace Prince Tungi showed me the tortoise, now partially blind and considerably battered as the result of bush fires (in which it was three times caught) and of an injury from a heavy limb of a tree falling on it and partially crushing its shell. Otherwise the tortoise was doing as well as could be expected at his age, possibly 200 years and certainly more than 160 years."

Sir Joseph further states: "Two tortoises were brought, but one died. The other, Tu'i Malila, is still alive. The name originated from the residence of the Tu'itoga, the name of which is Malili; and the name, "King of Malila," was given to the tortoise, which had free run of the grounds. The tortoise was cared for by the people, just as if it were a chief, and it went where it pleased in Tonga."

At various times in past years expeditions have visited the Galápagos for the purpose of bringing back living tortoises for zoological gardens, notably those of New York and London. In 1897 the schooner *Lila and Mattie* arrived in San Francisco with live tortoises to be shipped to London, and in 1902 the schooner *Mary Sachs* arrived with a load for the same destination. Another schooner, the *W. S. Phelps*, Captain Richard Nye, arrived in 1902 with a cargo of 37 live tortoises. One of these is still

At Left—Young Green Turtles *(Chelonia agassizii)* on the Sand at Black Beach Road on Charles Island.

Below—A Green Turtle Nest Dug Out at Black Beach Road on May 15, 1932, Contained 92 Empty Egg Shells and Three Infertile Eggs. Tracks of Many Recently Hatched Turtles Were Found, Leading Toward the Water. (Photos by Toshio Asaeda)

living in the zoological garden at San Francisco.

Distribution and Present Status of the Galápagos Land Tortoises—Tortoises had been found on Abingdon, James, Duncan, Indefatigable, Chatham, Hood, Charles, and Albemarle islands previous to the Academy's expedition of 1905-1906. Narborough and Jervis islands were then added to the list. Old eggs were dug out of the ground and tortoise remains were found on Barrington island, but there are no records of living tortoises ever having been taken there.

There are fifteen species credited to the archipelago. Albemarle has five, but each of the other tortoise islands has its own individual species. The status as given by Van Denburgh in 1914 is as follows:

Name	Island	Present status
1. *Testudo abingdoni*	Abingdon	Rare
2. *phantastica*	Narborough	Very rare
3. *becki*	Albemarle (North)	Fairly numerous
4. *ephippium*	Duncan	Fairly abundant
5. *hoodensis*	Hood	Very rare
6. *elephantopus*	Charles	Extinct
7. *darwini*	James	Rare
8. *chathamensis*	Chatham	Nearly extinct
9. *microphyes*	Albemarle (Tagus Cove)	Fairly numerous
10. *güntheri*	Albemarle (Southeast)	Abundant
11. *vicina*	Albemarle (South)	Fairly numerous
12. *wallacei*	Jervis	Very rare
13. *porteri*	Indefatigable	Not rare
14. *species?*[1]	Albemarle (Cowley Mt.)	Rare
15. *species?*	Barrington	Extinct

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[1] Now named *Testudo vandenburghi* for the late Dr. John Van Denburgh.

Of late years tortoises have been taken on Hood, Duncan, Indefatigable, and Albemarle islands. At the present time they are extremely rare on Hood, Abingdon, James, Jervis, Chatham, and Narborough islands, and they are certainly extinct on Charles and Barrington. On the Academy's expedition living tortoises were seen but not taken on Duncan, James, and Abingdon islands. The expedition of the *Albatross II* in 1928 showed them to be still abundant on South Albemarle, and no doubt they are still common on Duncan island. Owing to the fact that Indefatigable island now has permanent inhabitants, the tortoises will probably be thinned out considerably. In all places except South Albemarle, Duncan, and possibly Indefatigable, it would take persistent hunting by a person familiar with their habits ever to find one.

The Sea Turtle

The common Green Turtle (*Chelonia agassizii*), ranging throughout the tropical waters of the Pacific and reaching as far North as Lower California, is the marine turtle found commonly in the waters of the Galápagos. Although they are particularly common in some of the large lagoons, such as those on the northern coast of Indefatigable, and wherever there are fine sand beaches, as at Gardner Bay Hood island, they may be found anywhere about the archipelago from Culpepper island on the North to Hood island on the South.

Habits—From the stomachs of the Green Turtles examined, it appears in its natural state to be principally a vegetarian although in captivity it readily eats fish and meat, and particularly is fond of the young shoots of the mangrove. For this reason it is usually common about the lagoons and coast line wherever the mangroves grow in abundance. It frequently hauls out on the sand beaches to dry off, and it is here the female comes ashore to deposit her eggs, the nesting season beginning about the month of May. The female hauls up just above the high tide line, where she digs a moderately large hole, two or three feet deep, and deposits from 100 to 200 eggs. These are white, about one inch in diameter, with a thin leathery shell. The turtle covers the eggs with sand, smoothing off the top of the nest to the beach level with her flippers, and leaves them to be hatched by the heat of the sun. The period of incubation is from six to eight weeks, when the turtles, breaking their way through the egg shell, work their way to the surface and make directly for the water. The adult turtle has few if any enemies other than man. Probably a shark bites off a flipper now and then, but the greatest mortality takes place among the young which are devoured by the larger fish, and only a very small percentage of those which reach the water survive.

The Sea Iguana

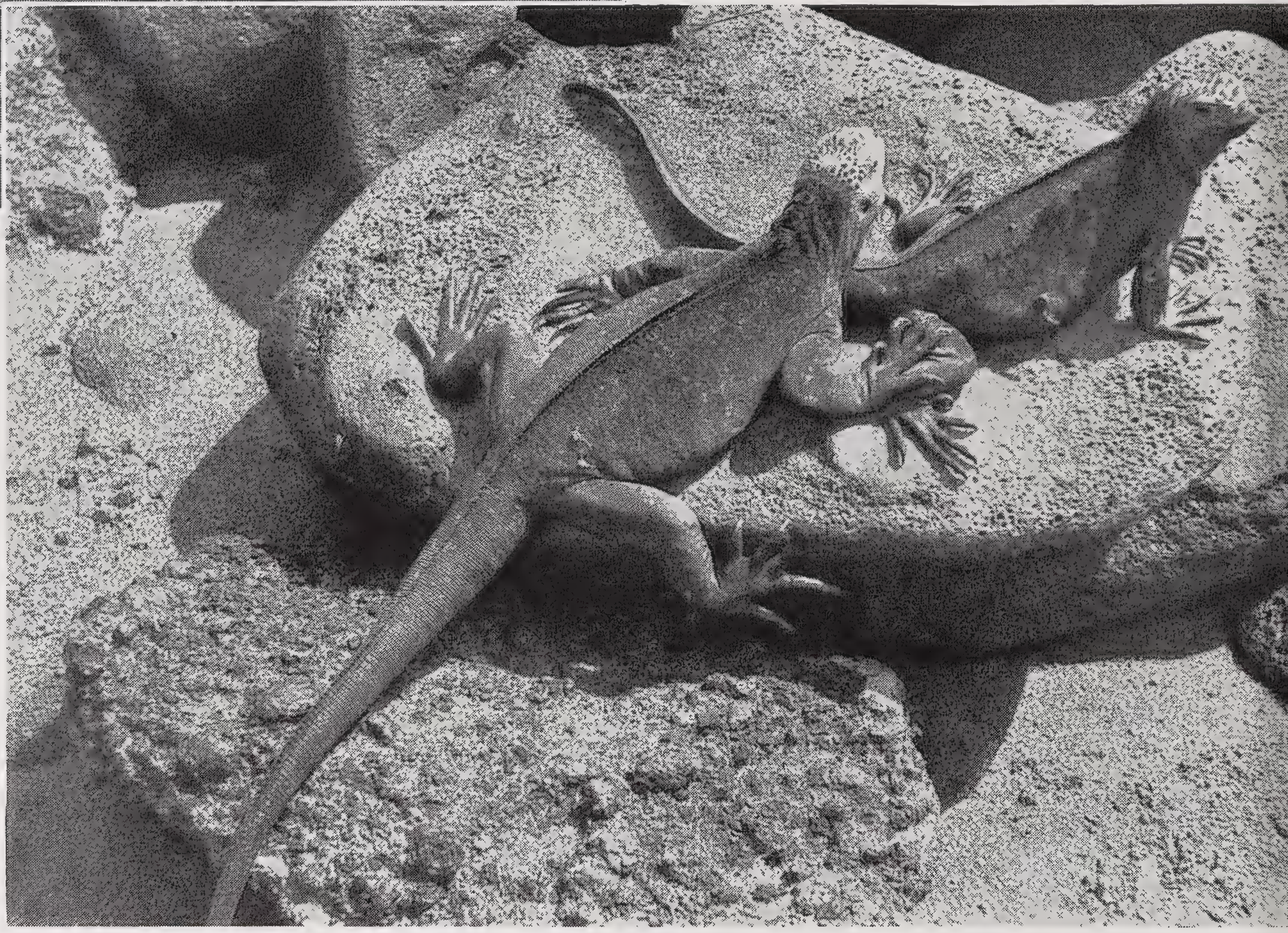
Next in point of interest to the Giant Land Tortoise is the Sea Iguana (*Amblyrhynchus cristatus*), the only lizard in the world solely dependent on the ocean for its food, and confined strictly to the Galápagos archipelago. Some of the large males reach a length of five feet and exceed the Land Iguana in size. The largest individuals have been found at Iguana Cove, Albemarle, and off the South coast of Indefatigable to the westward of Academy Bay. In 1875 Commander Cookson of HMS *Peterel* reported that the rocks about Iguana Cove were thickly covered with Sea Iguanas and that they were more numerous than at any other place. They were found to weigh twenty to twenty-two pounds, against twelve to fourteen pounds from other localities.

Lieutenant Shillibeer reported Sea Iguanas common on Charles island under the date of July

While Swimming, the Sea Iguana Keeps Its Legs Close to the Body and Propels Itself by an Undulating Movement of the Body and Tail. (Photo by George Stone)

At Left—Sea Iguanas Inquisitively Watch the Preparations of the Cameraman. (Photo by George Stone)

Below—*Amblyrhynchus cristatus* Enjoys Basking on the Lava Boulders at Conway Bay, Indefatigable Island. (Photo by John Tee-Van)



25, 1813. He says: "Guanas we found here in great abundance, and notwithstanding their disgusting appearance, they were eaten by many of the sailors, who esteemed them as most delicious food." A subsequent entry in his journal shows that he is referring to the Sea Iguana.

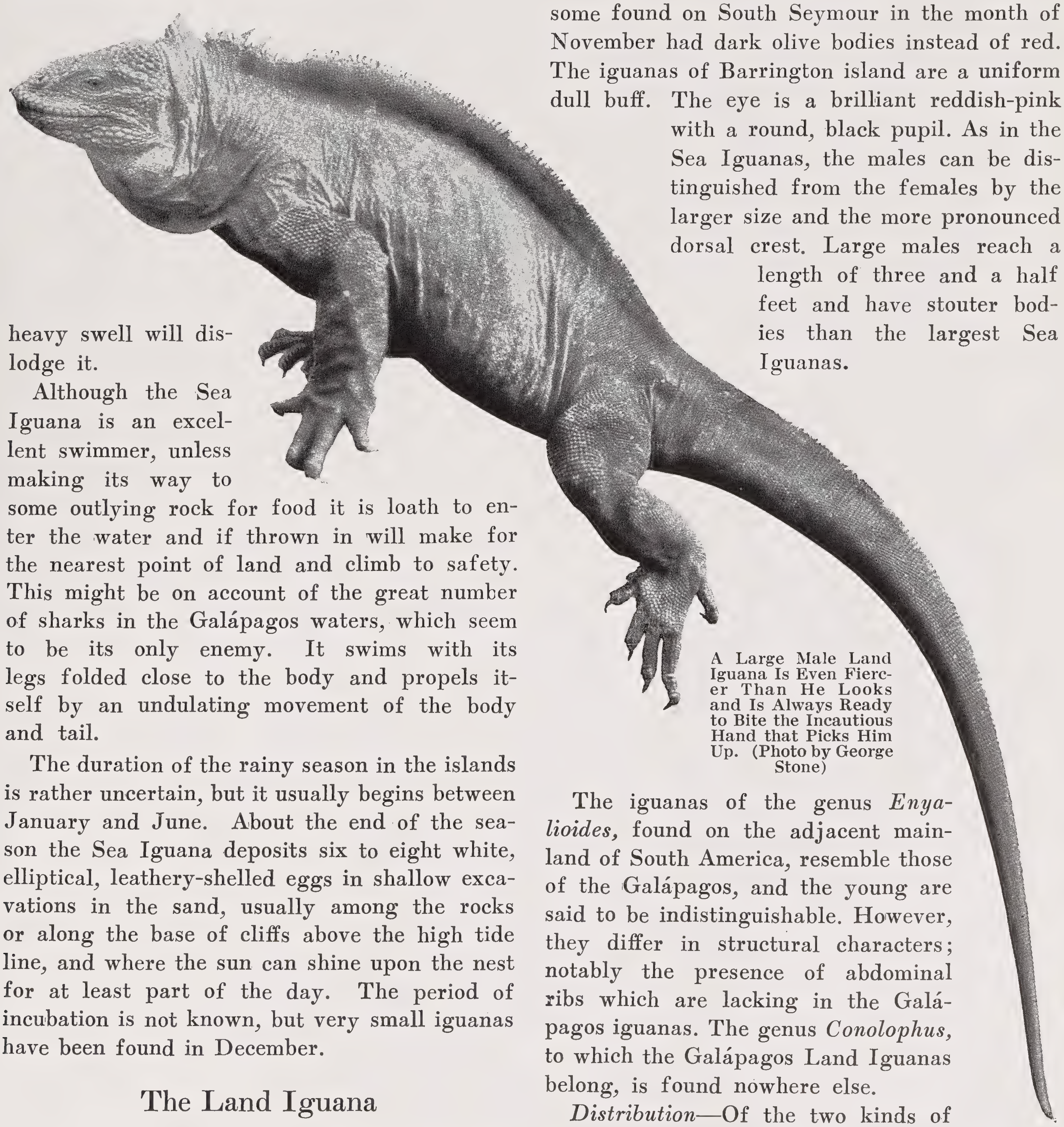
The Sea Iguana has a strongly compressed tail, flattened for swimming and large convex or conical shields on the top of the head. A dorsal crest of large, lanceolate spines extends from the back of the head almost to the tip of the tail. The claws are long and sharp, the digits compressed and united at the base with a rudimentary web. The eye is chestnut-brown, with a round, black pupil.

During the mating season the Sea Iguanas are brilliantly marked with large blotches of metallic green and red, but at other seasons of the year the coloring is quite somber with only traces of dull red and green on a ground color of black. The smaller iguanas are a uniform dull black.

Despite the fact that they are armed with sharp tricuspid teeth, they never offer to bite or even open their mouths when picked up by the tail.

Distribution—There is but one species of Sea Iguana and it has been found on nearly all of the islands and islets of the archipelago. It is still common or abundant on all but Chatham and Charles. On account of the wild dogs it has become very rare on the former and probably extinct on the latter. However, it is common on Champion and Enderby, about a mile off Charles, where there are no dogs.

Habits—The Sea Iguana never wanders from the coast line but confines itself closely to the rocks along the water's edge or to the sand beaches. Its food consists solely of "sea lettuce," an alga which it gathers off the rocks at low tide. When not feeding, the Sea Iguana generally resorts to the lava boulders where it may be found singly or in pairs or in colonies basking in the sun. In places, the rocks are discolored over large areas from the droppings of generations of iguanas at some favorite spot. Some herds seen on Narborough island contained hundreds of individuals. When the tide is low the Sea Iguana crawls over exposed flats or swims to the outlying rocks to feed. If it happens to be on a rock that is swept by the sea, it keeps a close watch on the approaching swells. As the incoming sea is about to break, the iguana crouches close, allowing the water to wash completely over it; the long, sharp claws enable it to cling so tightly that not even a heavy swell will dislodge it.



A Large Male Land Iguana Is Even Fiercer Than He Looks and Is Always Ready to Bite the Incautious Hand that Picks Him Up. (Photo by George Stone)

Although the Sea Iguana is an excellent swimmer, unless making its way to some outlying rock for food it is loath to enter the water and if thrown in will make for the nearest point of land and climb to safety. This might be on account of the great number of sharks in the Galápagos waters, which seem to be its only enemy. It swims with its legs folded close to the body and propels itself by an undulating movement of the body and tail.

The duration of the rainy season in the islands is rather uncertain, but it usually begins between January and June. About the end of the season the Sea Iguana deposits six to eight white, elliptical, leathery-shelled eggs in shallow excavations in the sand, usually among the rocks or along the base of cliffs above the high tide line, and where the sun can shine upon the nest for at least part of the day. The period of incubation is not known, but very small iguanas have been found in December.

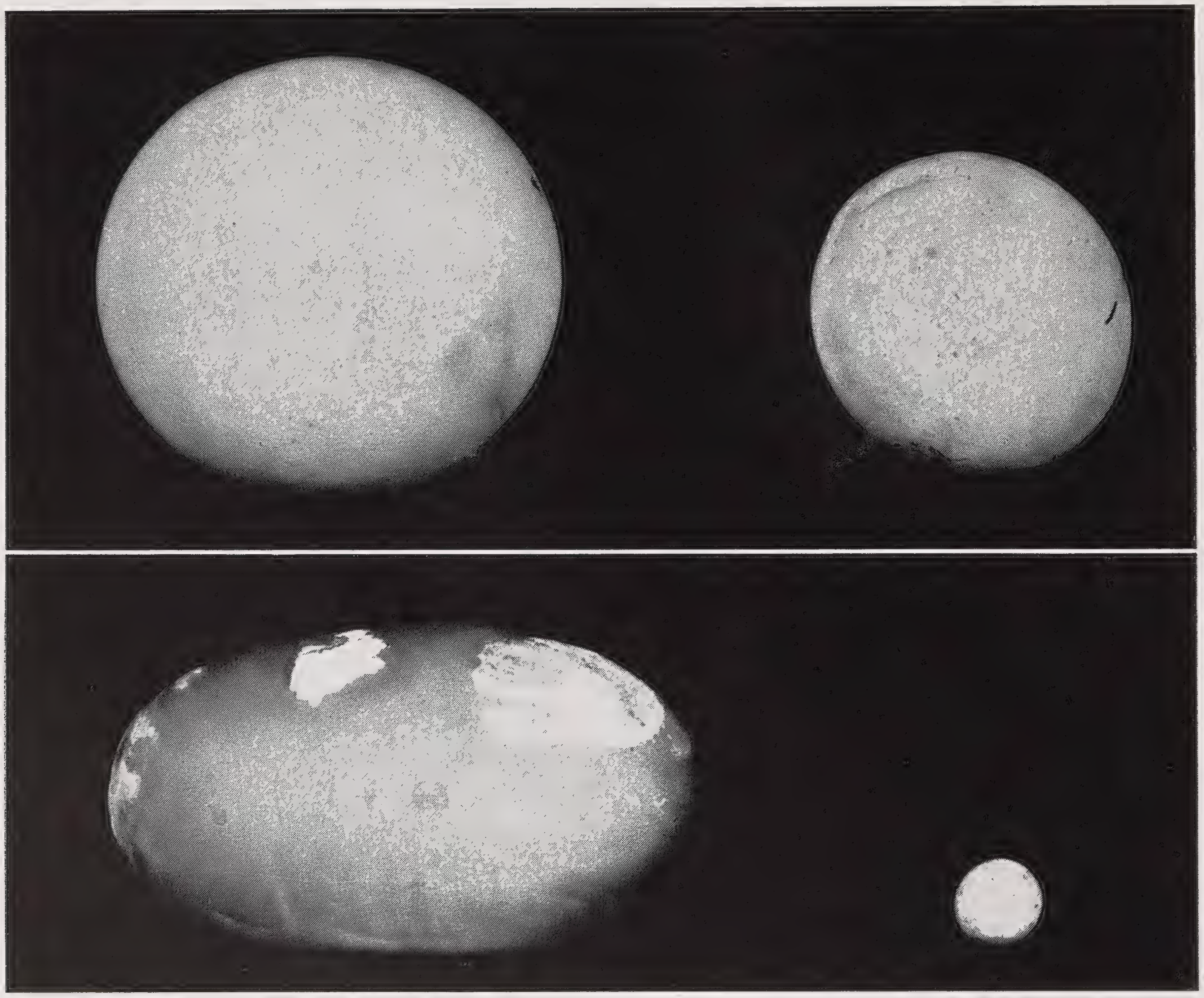
The Land Iguana

The Land Iguana differs from the Sea Iguana both in form and coloration. The tail is rounded instead of flattened and there is no trace of a web at the base of the digits or toes. The head is considerably longer, the jaws more powerful, and the large conical head-plates characteristic of the Sea Iguana are lacking.

The general coloration of the Land Iguana inhabiting South Seymour, Narborough, Albemarle, and Indefatigable islands is reddish on the body with yellow head and feet, but some found on South Seymour in the month of November had dark olive bodies instead of red. The iguanas of Barrington island are a uniform dull buff. The eye is a brilliant reddish-pink with a round, black pupil. As in the Sea Iguanas, the males can be distinguished from the females by the larger size and the more pronounced dorsal crest. Large males reach a length of three and a half feet and have stouter bodies than the largest Sea Iguanas.

The iguanas of the genus *Enyalioides,* found on the adjacent mainland of South America, resemble those of the Galápagos, and the young are said to be indistinguishable. However, they differ in structural characters; notably the presence of abdominal ribs which are lacking in the Galápagos iguanas. The genus *Conolophus,* to which the Galápagos Land Iguanas belong, is found nowhere else.

Distribution—Of the two kinds of Land Iguanas found in the archipelago, one species (*Conolophus pallidus*) is confined to Barrington island and the other (*Conolophus sub-*



Above (Left)—The Hard-Shelled Egg of the Giant Land Tortoise *(Testudo güntheri)*. (Right) The Thin, Leathery-Shelled Egg of the Green Turtle *(Chelonia agassizii)*. Natural Size.

Below (Left)—The Leathery-Shelled Egg of a Galápagos Land Iguana *(Conolophus pallidus)* Compared with the Little, Hard-Shelled Egg of the Gecko *(Phyllodactylus tuberculosus)* at the Left. Natural Size. (Photos from California Academy of Sciences)

cristatus) has been taken on Narborough, South Seymour, Albemarle and Indefatigable islands. The latter species is still common on South Seymour and Narborough but very rare on Albemarle and Indefatigable. On Albemarle an occasional one may be met with around the base of Tagus Cove mountain, and on Indefatigable in the vicinity of Conway Bay. The *Hassler* expedition (1872) reported that Land Iguanas were common at Tagus Cove. On James island they are probably extinct. Some bones were found on the Academy's expedition of 1905-1906, but no signs of living iguanas or recent burrows were discovered. Captain Abel de Petit-Thouars, of the French Frigate *Venus,* reported them (1836) numerous on James island. The introduction of dogs was the primary cause of the decline in numbers, although natives who killed them for food are partly responsible.

Habits—On Barrington island the iguanas were found to be living in a colony on a plateau near the center of the island, the females inhabiting burrows in the loose soil and most of the males living in the rock piles encircling the plateau. The ground is composed of soft volcanic ash in which burrows can be dug with ease. These are about three feet in depth and dug obliquely into the earth. On South Seymour and Narborough the iguanas are found scattered promiscuously about the islands, and not in a colony such as was found on Barrington. South Seymour is a low, flat island and is not to be taken as representative of the elevation at which they may be found elsewhere. On Narborough which, according to the South America Pilot, is 3,720 feet high and according to the Hydrographic Office chart 4,320 feet, they range from sea level to the rim of the crater.

Great numbers of old burrows are still to be found on Albemarle and Indefatigable and judging from the extent of these extinct colonies their numbers must have run into the hundreds and possibly to a thousand or more. Darwin, in his "Journal of Researches" (*op. cit.*) says of the colonies on James island: "I cannot give a more forcible proof of their numbers than by stating that, when we were left at James island, we could not for some time find a spot free from their burrows on which to pitch our single tent."

Lieutenant Shillibeer remarked that, "The number of guanas we saw here, can alone be conceived; they had regular burrows, and were much more plentiful than I have ever seen rabbits in a preserve in this country. They are of a light red color, about two to three feet long, and when pursued, do not like those at Charles Island, take to the water."

The Land Iguana feeds on almost any sort of vegetation and although mostly terrestrial is occasionally found climbing up the low bushes or trees where it can reach the flowers or the fruit of the cactus.

Although awkward in their movements, they can cover the ground at a fair rate of speed for a short distance. When chased they usually make for a rock pile or their burrows, from which they can be pulled with ease by the tail.

The female deposits her eggs in the loose earth, allowing the heat of the sun to hatch them. The exact time they are deposited is not definitely known but females taken on Barrington island late in December had seven to ten white, elongate, leathery-shelled eggs ready for extrusion. These measured three inches in length and an inch and three-quarters in diameter. Strange to say, recently hatched young have never been found.

Unlike the Sea Iguana, which is very docile, the Land Iguana is extremely vicious. When held by the tail it will keep its mouth wide open

Passing Close to Mangrove Point on Narborough Island, the Captain G. Allan Hancock Expedition Found One of the Minor Craters in Eruption and the Molten Lava Pouring Into the Sea Through a Subterranean Tunnel. (Photo by George Stone) ready to grab whatever comes within reach, and the sharp, tricuspid teeth and powerful jaws enable it to inflict a severe bite.

The Lava Lizards

Next to the iguanas, the moderate sized Lava Lizards attract the attention of the visitor. The genus *Tropidurus,* to which they belong, is not confined to the Galápagos but is found throughout a greater part of South America and a closely allied genus (*Liocephalus*) occurs in both South America and the West Indies. However, none of the species occurring on these islands is found elsewhere. The Lava Lizards of several of the islands may appear similar to the casual observer, but a more thorough examination of those from Abingdon, Duncan, Bindloe, and Chatham islands will at once show that they differ from each other and from those of the other islands of the archipelago, a fact which tends to show an early isolation of these particular islands. Those of Hood island have the largest males of any of the species, reaching a length of twelve or thirteen inches and differing greatly from the females in both size and coloration. The males have large crests, many irregular black spots on the back, with much red on the sides and belly, while the females are a dull uniform olive with brick-red heads and throats. The males of all of the species may be distinguished by the larger size and the more pronounced dorsal crest.

The principal enemy of the Lava Lizards is the Galápagos Hawk, while the snakes account for a few. On Charles island where cats have been introduced, this lizard has become almost extinct. Only occasionally is it met with on the lava beds at the North end of the island.

Distribution—Lava Lizards occur on almost every island and islet of the archipelago, the most notable exceptions being Culpepper, Wenman, and Tower islands. There are several of the islands each having its own peculiar species, but no island has more than one. The following list of species and of the islands on which they occur is made from a study of the material secured on the Academy's expedition of 1905-1906:

	ISLAND
Tropidurus pacificus	Abingdon
duncanensis	Duncan
habelii	Bindloe
bivittatus	Chatham
delanonis	Hood
	Gardner (near Hood)
grayii	Charles
	Gardner (near Charles)
	Champion
	Enderby
albemarlensis	Indefatigable
	South Seymour
	North Seymour
	Daphne
	James
	Jervis
	Cowley
	Brattle
	Albemarle
	Narborough
albemarlensis barringtonensis	Barrington

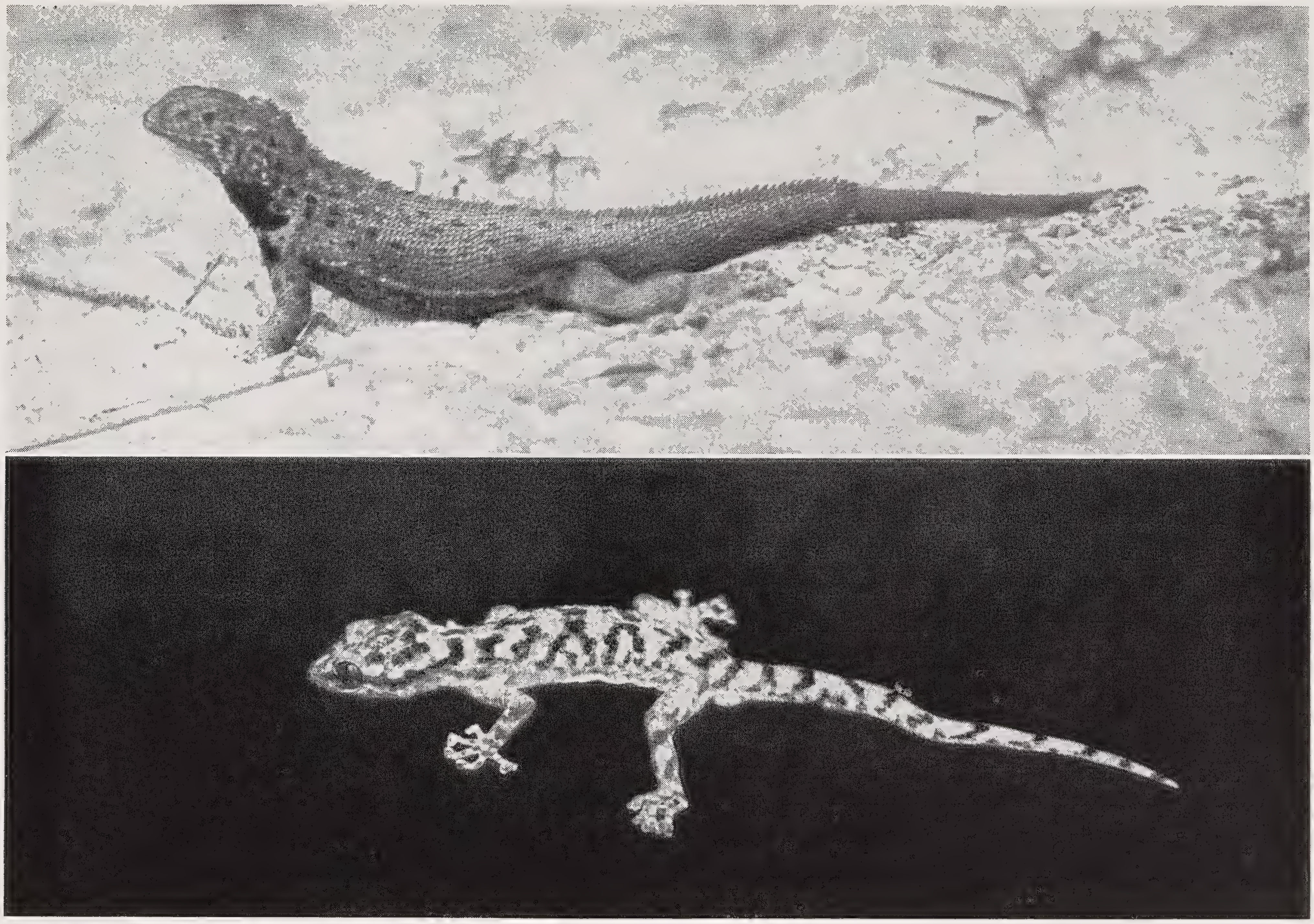
Habits—On the smaller islands these lizards range from the shore line to the summit, but on the larger ones they are found more commonly along the coast. They are never seen high up in the green zone of the mountains, as on Albemarle and Indefatigable, and are rarely seen above 800 or 900 feet.

In the months of May and June females were seen digging holes in the sand, no doubt for depositing their eggs, and during this time were found with three to six eggs about ready for extrusion. These were about an inch long and, like the eggs of the iguana, have a soft, leathery shell.

Although these lizards are mostly terrestrial they at times climb into the bushes and to the tops of the cactus leaves to get the fresh buds. While a large portion of their diet is composed of vegetable matter, they also feed on grasshoppers, flies, beetles, and other insects.

The Geckos

The remaining lizard of the archipelago is the Gecko, belonging to the widely distributed genus *Phyllodactylus.* Geckos of this genus are found in South America, Central America, South



Above—A Male Galápagos Lava Lizard *(Tropidurus delanonis)* on Hood Island. The Tail Has Been Broken Off and Has Regrown. (Photo by Toshio Asaeda)

Below—This Species of Gecko *(Phyllodactylus tuberculosus)* Was Found on Chatham Island. The Vertical Pupil of the Eye Can Easily Be Observed in the Living Specimen, and the Picture Shows the Peculiarly Shaped Toes. Natural Size. (Photo from California Academy of Sciences)

Africa, the Antilles, the United States, and Australia.[1]

The Geckos of the Galápagos can readily be distinguished from the Lava Lizards by their small size (the largest are not more than four inches long), by the character of the skin, which is very delicate and soft and covered with minute tubercles, and by the peculiar construction of the feet. Close examination will show that each digit has many transverse lamellae or thin leaf-like processes. Pressing down the foot on any surface forces out the air and minute vacua are produced by a partial retraction, which allows the lamellae to resume their original position. It is thus that the Gecko is enabled to climb smooth and vertical surfaces or to run along the ceilings. The pupil of the eye is vertical, instead of round as in the Lava Lizards, showing that it is nocturnal in its habits, and it has no movable lid. The ground color of the Gecko is a light gray, sometimes with dark or black reticulations. At night, when these little lizards are under a bright light, they appear to be almost transparent.

Although Geckos are perfectly harmless, it seems to be a popular belief throughout the world that they are extremely venomous and even deadly.

Distribution—The distribution of the Galápagos Gecko is as follows:

	Island
Phyllodactylus tuberculosus	Chatham
leei	Chatham
barringtonensis	Barrington
gilberti	Wenman

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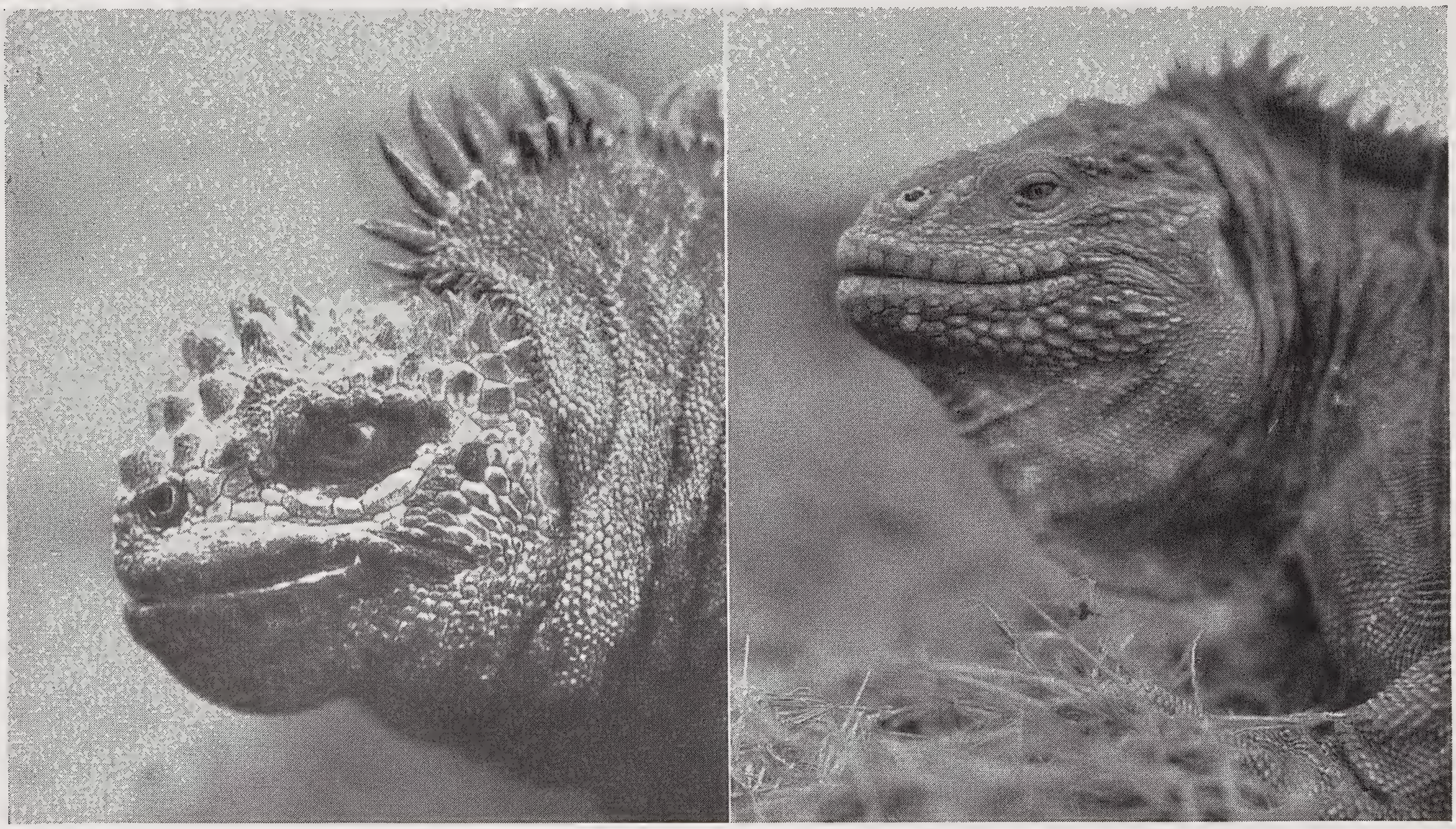
[1] A second genus of Gecko (*Gonatodes*) has been reported as having been taken on Chatham island by Dr. George Baur, but as it has never been taken by any other collector, despite the fact that hundreds of Geckos have been collected on Chatham, other authors have suggested that it might have been at Guayaquil, where Dr. Baur also collected, and that there was a mistake in the labeling of the collections.

bauri	Charles
	Gardner (near Charles)
	Champion
	Enderby
	Hood
	Gardner (near Hood)
galapagoensis	Indefatigable
	James
	Cowley
	Brattle
	Albemarle
galapagoensis daphnensis	Daphne

As is seen in the foregoing list, Chatham is the only island having more than one species of Gecko. One of these (*Phyllodactylus tuberculosus*) is a very widely distributed species, and thus may be assumed to be a recent importation, all of the other species found in the Galápagos having been developed by evolution. No Geckos have, as yet, been taken on Culpepper, Abingdon, Bindloe, Tower, or Narborough islands. No doubt they are on most of them but on account of their secretive habits have not been found.

Habits—Geckos are really beneficial in tropical countries where they are found most commonly, as they frequently inhabit the houses, feeding on the numerous insects which help to make life unpleasant. In the daytime they secrete themselves back of pictures on the walls, in hollow bamboo rafters, and in the thatched roofs. As it turns dark they emerge from their hiding places and lie in wait around the lights for any insects which may come near. On sighting their prey, they scurry across the ceiling and grab their victims with such speed that the eye has difficulty in following.

Like the Lava Lizards, the Galápagos Geckos are confined more or less to the lower levels and are rare above 1,500 feet. Being so small and also nocturnal, a visitor to the islands would probably not meet the species unless he knew just where to look. Where there are no habitations, Geckos hide under stones, the bark of trees, in the dead branches, and in hollow stalks of dead brush. In most places it requires considerable hunting to find them but at Black Beach Road on Charles island they seem to be particularly abundant and easy to find. By



At Left—The Head of a Sea Iguana *(Amblyrhynchus cristatus)*. Note the Conical Shields on the Top of the Head and the Short Mouth.

At Right—The Head of the Land Iguana *(Conolophus subcristatus)* Shows More Powerful Jaws, a Larger Mouth, and a Lack of the Conical Shields of the Sea Iguana. (Both Photos by George Stone) turning over stones in the vicinity of the landing it would not be difficult to find numbers of them. Where there are good sand beaches they may be found at night just above the high tide line, running along the edge of the piles of debris washed up by the sea. Here they feed on various minute insects, ants, and flies, which form a considerable portion of their food.

The Gecko lays its eggs under stones or in the trunks of hollow trees sometimes ten or more feet above the ground. The eggs, sometimes three or four but mostly two in number, are globular or slightly oval in shape, about ten or eleven millimeters in length, with thin, white, hard shells. Broken shells are often found under stones and the bark of trees. Fresh eggs were taken in April.

The Snakes

Seven species of Land Snakes and one species of Sea Snake have been reported from the Galápagos. The Land Snakes belong to the genus *Dromicus,* also found on the adjacent mainland, and are distributed as follows:

	Island
Dromicus biserialis	Charles
hoodensis	Hood
	Gardner (near Hood)
slevini	Duncan
	Narborough
	Albemarle (Cowley Mountain)
steindachneri	Indefatigable
	South Seymour
	Jervis
dorsalis	James
	Indefatigable
	South Seymour
	Barrington
occidentalis	Narborough
occidentalis helleri	Brattle
	Albemarle (Cape Berkeley)

None of these species is found elsewhere than on the Galápagos. These snakes are nonvenomous, rather slender in form, and reach a length of from three to four feet. To distinguish the various species requires a somewhat close study, but the casual observer will note that there are two distinct types of coloration: striped and a spotted form. Both may belong to the same species and be found on the same island. Snakes are found most commonly on Hood and Indefatigable islands.

No snakes have been taken on Culpepper, Wenman, Abingdon, Bindloe, Tower, or Chatham islands.

Habits—Like the lizards, the Galapágos Land Snakes are generally found in the brushy areas of the lower levels. They are considerably more shy than the other reptiles and will not allow too close an approach. If frightened, they at once seek the cover of some sheltering crevice in the lava. Their food consists of lizards, both the Gecko and the Lava Lizard, grasshoppers, beetles, and various other insects. Nothing is known concerning the breeding habits of Galápagos Land Snakes.

A Yellow-bellied Sea Snake (*Pelamis platurus*) was recorded by the Academy's expedition of 1905-1906 between Chatham and Hood islands. This is the only other species of snake found in the archipelago and is the most widely distributed of any of the salt water snakes, being found from Indo-Australian waters as far North as southern Siberia, and South of Tasmania. It ranges in an easterly direction across the Pacific to the coast of Central America and is found abundantly in the Gulf of Panama.

This Sea Snake belongs to the *Proteroglypha,* a group of snakes which have the anterior maxillary teeth deeply grooved or folded, so as to appear hollow. Like all other sea snakes, it is venomous and human deaths from the bite have been reported.

This particular species is probably the most variable in coloration of any of the sea snakes. The most common coloration is a dull black with yellow and brown on the sides and belly, the two colors being well defined. However, some may be yellow on the sides and belly with a vertebral series of spots, and some entirely yellow. The tail is usually yellow with black or bluish bars. This extreme variation has led some students to believe that they were dealing with several distinct species, but it is now recognized that these differences are simply color variations of different individuals that are all of one kind.

In their natural habitat the sea snakes are graceful and rapid swimmers and are often seen coming to the surface to breathe, then diving down again with remarkable rapidity, the nostrils being fitted with an interior valve which may be opened during respiration and closed when diving. The flattened tail, specialized for life in the water, enables them to dive with swiftness and grace. Their food consists of small fish which are killed by the action of the venom before being swallowed.

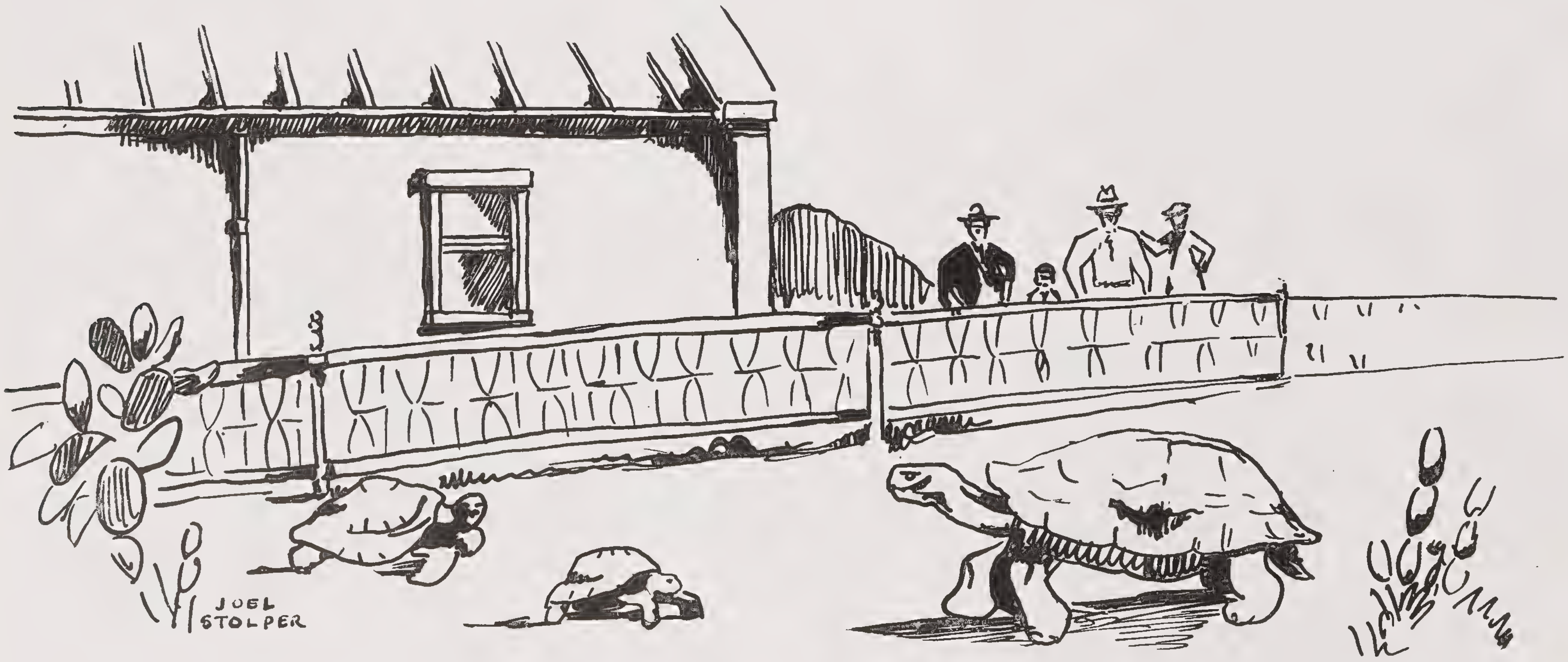
At times *Pelamis platurus* may be seen in large numbers while basking upon the surface of the water along the Central American coast, or it may be seen at night under the anchor lights of vessels. Like all other sea snakes, it is viviparous. During the breeding season the female visits small rocky inlets or tide pools to give birth to the young. The adult reaches a length of about three feet. Raptorial fish and birds of prey seem to be the chief enemies.

Summary

A study of the reptiles tends to show that at one time the Galápagos archipelago was a single land-mass, which at some remote geological period gradually broke up to form the present group of islands. As a gradual depression took place, the higher parts became isolated islands, and through a long period of time changes took place in the isolated colonies of reptiles, producing specific and subspecific differences. Each island has its own species of *Tropidurus,* and each, with the exception of Albemarle, its own species of tortoise. Study of the tortoises of Albemarle island leads one to the conclusion that at one time its five mountain peaks were separate islands and remained so long enough to permit specific characters to develop; hence it has five species of tortoises. There is evidence that at some period during the formation of the archipelago, an elevation of the ocean bottom took place, joining the five peaks of Albemarle so as to form the present island. Terraces containing the characteristic cavities made by sea urchins were found several hundred feet above sea level, near Tagus Cove, and old sea cliffs situated inland from Iguana Cove give proof of a recent elevation having taken place.

In the formation of the present archipelago a study of the lizards of the genera *Tropidurus* and *Phyllodactylus* tends to show that the breaking up of the land-mass began at the northern part, and that Wenman, Abingdon, and Bindloe became separate islands to the northward. Changes then taking place in the southern portion, Hood and Chatham separated from the main island, leaving a large arm or bay extending northward and isolating Duncan island.

The remaining portion, no doubt, formed a single island for a long time after the separation of the northern and southern islands, but their history is much more difficult to trace, differentiation in the reptiles not having reached an advanced stage as yet.



Observations on the Seasonal Hair Moult in a New York State Weasel (*Mustela noveboracensis*)

CHARLES V. NOBACK

A NEW YORK STATE weasel (*Mustela noveboracensis*) which had been kept by Dr. W. J. Hamilton, Jr., of the Department of Zoology at Cornell University at Ithaca, New York, for more than two years, was sent to the New York Zoological Park and was received on June 29, 1933.

The slender, active, and nervous creature was about eight inches long, with keen, black, beady eyes and black-tipped tail. His white abdomen faintly tinged with yellow stood out in contrast to the brown summer body coat. On account of his highly sensitive nature, the weasel was kept in a secluded quiet place in order to avoid its being disturbed. Any undue noise caused it to become greatly excited and go into convulsions.

During the course of a few days the weasel, nicknamed "Herman the Ermine" by newspaper reporters, who watched his progress with interest, became very much at home when housed in a large, comfortable, half-inch wire mesh cage and fed on choice bits of fresh beef or mice, and supplied with a dish of clean and cool water. A wooden platform was provided at one end of the cage, where Herman would lie stretched out as he basked in the warm sunlight or romp about, according to his mood.

While the fact is known that weasels in northern latitudes may have a pure white winter pelage with a black-tipped tail and later during early spring acquire a coat of brown hair for the summer, relatively few records have been made as to when these changes in the hair coat take place and how long it takes before they are completed. In other words, what is the duration of the spring and fall moults?

It is naturally very difficult, if not impossible, to observe these lively creatures in their wild state in order to make accurate observations on their color changes. Consequently, observations as to when and how long it takes for these changes to occur can best be made by studies of captive specimens.

The literature on moulting in weasels has been carefully reviewed by Dr. Hamilton in his work, "The Weasels of New York: Their Natural History and Economic Status," published in The Midland Naturalist, Volume XIV, July, 1933, No. 4.

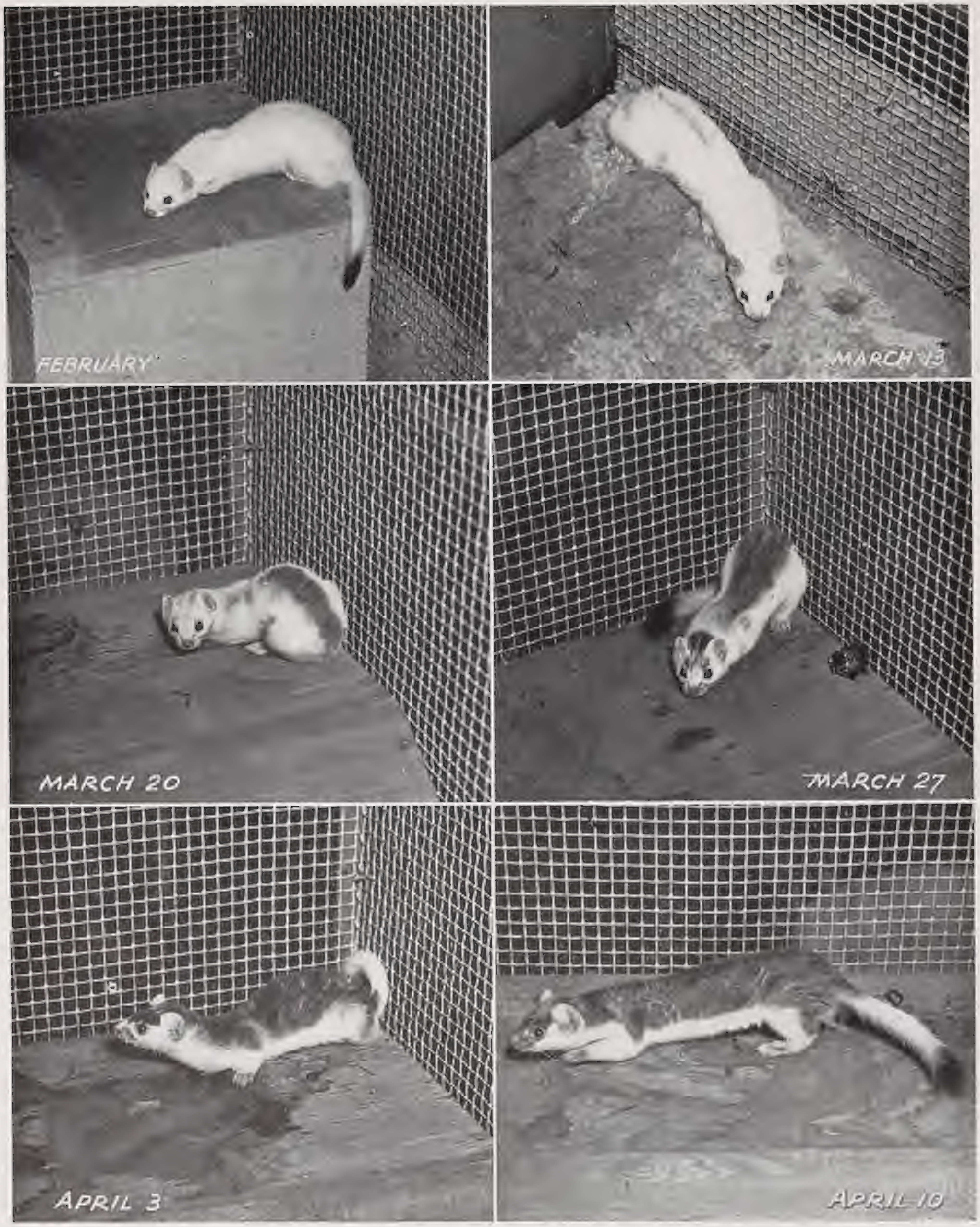
The purpose of this note is to record some observations made on the color changes in the hair coat of a captive New York State weasel.

During the summer and early fall of 1933 the weasel continued to remain brown except for the white abdomen and black-tipped tail. The first change in the color of the pelage or hair coat was noted on about October 15. At that time the first white hairs were seen around and between the eyes. During the following three weeks white hairs were observed cropping out along the sides of the face, on the shoulders, legs, and sides of the tail. The dorsal or upper part of the tail remained brown while the tip remained black.

On November 6 a considerable amount of white hair was seen to be present on the face, throat, ventral portions of the neck, part of the shoulders, forelimbs, abdomen, sides of the body (flanks), and tail, except its black tip. The dorsal portion of the tail was still mottled brown and white. The hair of the forehead, top of the head, the whole dorsal area of the body (back) from the nape to the tail was light brown with a sprinkling of white—pepper and salt. Fur trappers call this the "grayback" stage. They consider pelts of this kind valueless, since they are neither brown nor white. From the general appearance of the weasel at this date it seemed that the pelage would be pure white within about two more weeks.

The hair coat continued to change steadily from brown to white from November 6 to November 10.

The status of the color of the hair coat on November 11 was as follows: Small amounts of brown hair were present on the back of the head, neck, along the back, and upper flank. The brown hairs were being rapidly shed and replaced by white hairs. Some brown hairs were present on the sacral and gluteal regions, as



Herman the Ermine in His Great Transformation Scene—a Series of Photographs of a New York State Weasel *(Mustela noveboracensis)* Taken at Intervals of One Week as He Moulted from Winter to Summer Pelage. (Photos by Joseph Lyons, Staff Photographer of The New York *Sun*) well as at the base of the tail. The tail hairs were all white, except for the black tip. The remainder of the body was white.

On November 16 the outer margins of the ears were hairless and were pigmented light brown to yellowish. Traces of brown hairs were visible along the posterior half of the back; the remainder of the body was white.

Except for traces of brown on the haunches, the weasel was pure white on November 18.

On November 20 only a few very faint traces of brown hairs were present in the region on the tail and on the rump.

On November 22 the weasel at last was snowy white, except for the characteristic black tip on its tail. In its coat of pure white it closely resembled the ermine, a species of pure white weasel found in the Arctic regions, whose fur is highly prized and is used for making capes for royal personages.

It took about 37 days for the change or moult from the brown summer pelage to the white winter pelage to take place in this weasel. A picture of the weasel in his snowy white coat of winter is shown in the accompanying photograph.

During the winter months, Herman remained white until about March 5, when two narrow brown pencil-like stripes were seen just over the eyebrows and a faint brownish stripe began to show itself along the spine. These were the first indications that the change from the white winter pelage to the brown of summer was taking place.

By March 7 a clearly defined band of brown became clearly visible along the back from the shoulder to the base of the tail. It could now be recognized that the brown hair of the newly forming summer pelage was replacing the white winter hair.

Two brown stripes over the eyes and two brown stripes alongside the nose, together with a relatively broad band of brown over the posterior half of the back, showed the marked changes in color over a period of eight days—from March 5 to March 13—as illustrated in the photograph made on March 13.

Definite and striking changes took place in the hair coat during the next week. The brown stripes over the eyes, alongside the nose, the prominent brown patch on top of the head, and the clearly defined band of brown hair over the rump, stood out clearly in contrast to the white body, as can be seen in the photograph made on March 20.

From March 20 to March 27, the brown pelage was clearly apparent—solid brown from the face, over the top of the head, along the nape, over the back, along the sides, flanks, and part of the tail.

On April 7 the change had been practically completed and "Herman the Ermine" was clothed in his summer coat of brown. The spring change or moult lasted approximately 33 days.

The rhythm of color changes in the pelage of this weasel coincides with the seasons—white in winter and brown in summer. It is interesting to note that the specimen under observation had been kept indoors at a constant temperature of from 65° to 75° F. and had not been out of doors during the winter season. The color changes in this case coincided with the seasonal changes, as noted in some weasels under natural conditions.

The process of change appeared to manifest itself by a complete shedding of the brown, or colored hairs, for each morning clumps of brown hair were found on the floor of the cage.

There were no bare areas on the skin but instead new white hairs were present, indicating that perhaps new white hairs had grown out to replace the brown hairs and the latter were then shed. It seems that the old loose hairs caused a slight itching of the skin, because it was noticed that the weasel scratched himself and caused the old hair to fall out.

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Lee S. Crandall, *Curator, Birds*
William Bridges, *Editor and Curator, Publications*

NOTE: All pictures not otherwise credited are from the photographic collection of the Zoological Park.

The death of William White Niles, a member of the Board of Trustees of the New York Zoological Society, took place at his residence in this city on January 12, 1935.

The useful and earnest life of Mr. Niles was distinguished by his devotion to state and civic affairs and by his loyalty to the best interests of the Zoological Society for a period of forty years.

The following resolution expressing the sincere regret of the Executive Committee was duly adopted:

Whereas, William White Niles passed away on the twelfth day of January, 1935, and

Whereas, Mr. Niles was instrumental in amending and passing the Bill for the Charter and Incorporation of the New York Zoological Society while an Assemblyman at Albany, and

Whereas, Mr. Niles was closely identified with the organization and management of the Society and was the author of various amendments to the Charter, and

Whereas, he had served continuously on the Board of Trustees since 1898, and

Whereas, he had acted as the Executive Secretary of the Society since 1926, now therefore be it

Resolved, that his death is an irreparable loss to the Society and its work at the Park and Aquarium, and be it further

Resolved, that the Trustees of the New York Zoological Society hereby place on record their sense of profound loss and desire to express to Mr. Niles' family their deepest sympathy, and be it further

Resolved, that a copy of this resolution be sent to the family of the late William White Niles.

Elwin R. Sanborn

Mr. Elwin R. Sanborn, Editor and Photographer, whose services to the Zoological Society have extended over a period of more than thirty-five years, retired on pension on December 31, 1934.

It is no exaggeration to say that the work of Mr. Sanborn in the field of wild animal photography is in a class by itself, and beyond compare. The splendid library of photographic negatives which the Zoological Society possesses is the finest in existence and reflects great credit upon Mr. Sanborn's skill and artistic ability.

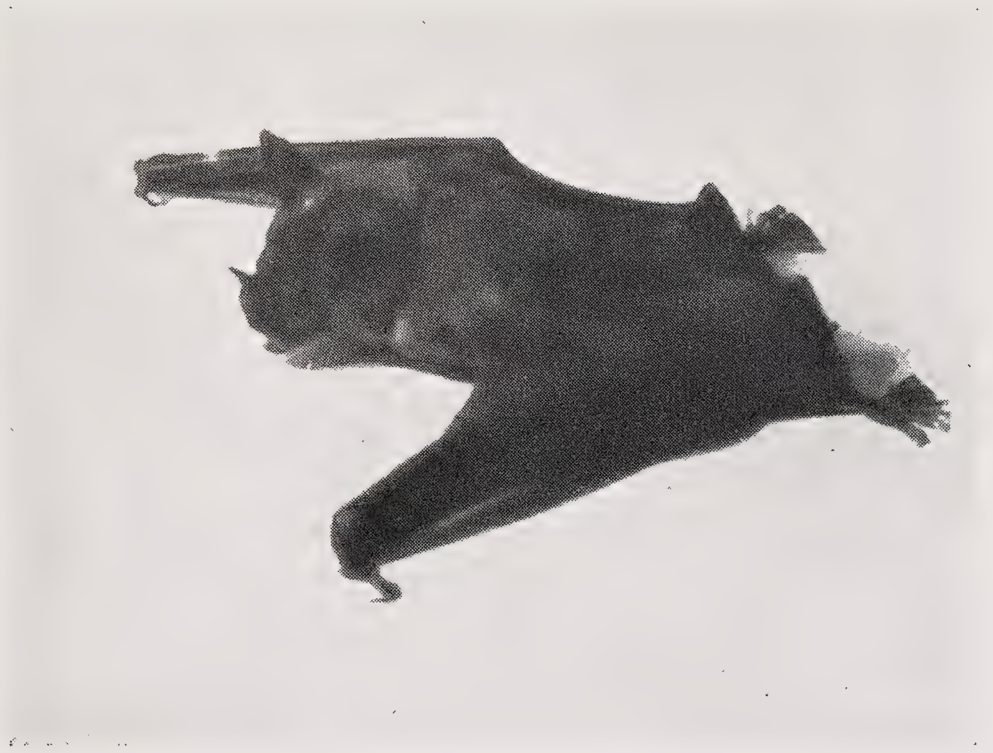
Mr. Sanborn retired with the good will and esteem of the officers of the Zoological Society as well as that of the officers and men of the Zoological Park, who wish him many years of enjoyment of the rest that he has so justly earned.

* * *

William Bridges

Mr. William Bridges, late of the New York *Sun*, has joined the staff of the Zoological Park as the Editor and Curator of Publications.

Mr. Bridges is a graduate of Franklin College, Franklin, Indiana, and since he has had extensive experiences as a writer and in the publishing field, the Zoological Society is fortunate in finding so able a man to undertake the important and constantly increasing duties connected with the publications of the Society.



This Grovelling, Spraddled Style of Walking Is Typical of the Large Spear-nosed Bat *(Phyllostomus hastatus panamensis* Allen). Its Progress on the Ground Is Awkward and Ungainly in the Extreme.

Vampire Research

Studies of the Vampire Bat are being continued by the Curator of Mammals and Reptiles. The results of investigations thus far have attracted quite broad attention, and were originally based upon a single Vampire Bat brought up from Panama.

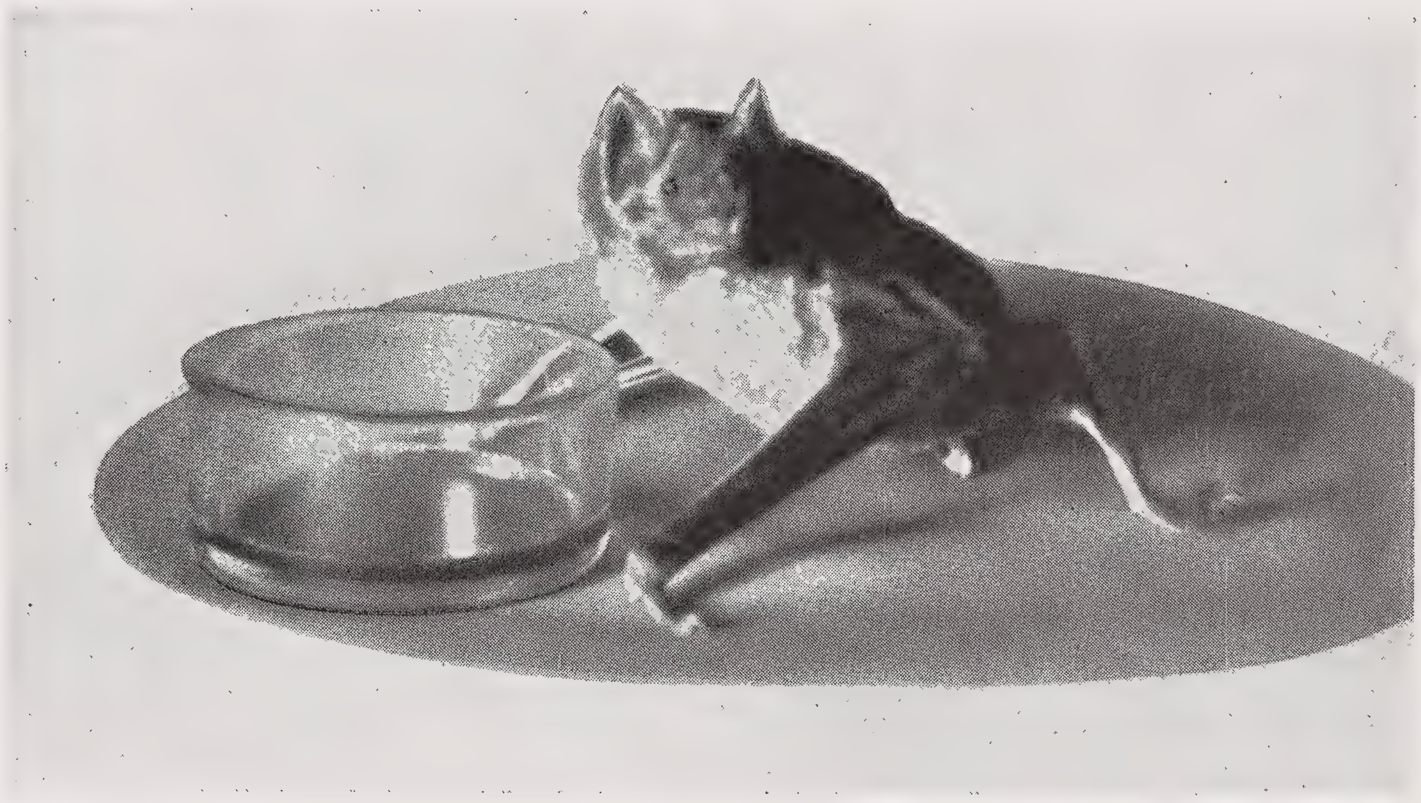
As this was the first Vampire Bat ever exhibited in a zoological institution it aroused great interest and newspapers from coast to coast printed articles about it. Visitors at the Park were very keen about seeing it, and the specimen was placed on exhibition in one of the large, glass-paneled cages in the Reptile House, where it was nightly provided with a dish of defibrinated blood from one of the slaughter houses.

As all sorts of stories and allegations about the habits of the Vampire Bat have appeared in various publications—in fact dubious assertions may be found in some rather formal books relating to natural history—the Curator of Mammals was anxious to study the habits of the new specimen carefully. This was difficult because of the bat's aversion to light, but the evening illumination near the cage was increased week after week until at last, in a light strong enough to note accurately what was happening, the bat would come down to the dish of defibrinated blood and consume her nightly meal. When this happened, surprising things were noted. The bat walked in slow and strange quadrupedal fashion. It also lapped its meal from the dish, with long, darting tongue.

Here was indication that the vampire was not a "blood-sucking" bat. If the action was persistent, there would be ample proof of this. Not only were the habits checked, night after night, but another steady increase of the light was made until it was possible to record all these formerly unknown habits on motion picture film.

With the film arranged as illustrative matter for a technical paper, this was presented before one of the scientific societies. There was the usual discussion and a final summary by the reader of the paper, to the effect that the habits observed quite changed the alleged history of the Vampire Bat and that the notes would soon be brought out in detail in a formal article to appear in *Zoologica.*

An unusual point of scientific ethics was brought up by one of the members of the society before which the pictures were shown. This was to the effect that a claim for the discovery of new habits, based upon a single specimen, were not satisfactorily convincing, even though the manifestations were constant in their repetition. The argument was based upon the possibility that the single specimen might be individually eccentric. This was a disturbing



On the Other Hand, the Vampire Bat *(Desmodus rotundus)* Is Remarkably Active on the Ground and Walks with a Free, Quadrupedal Motion. It Is Even Able to Hop.

note to the observer, who had worked through weeks of nightly vigils in checking the actions of an extremely difficult subject.

The argument brought about the decision, however, to obtain additional vampires, and in an area well separated from the country where the first bat had been captured.

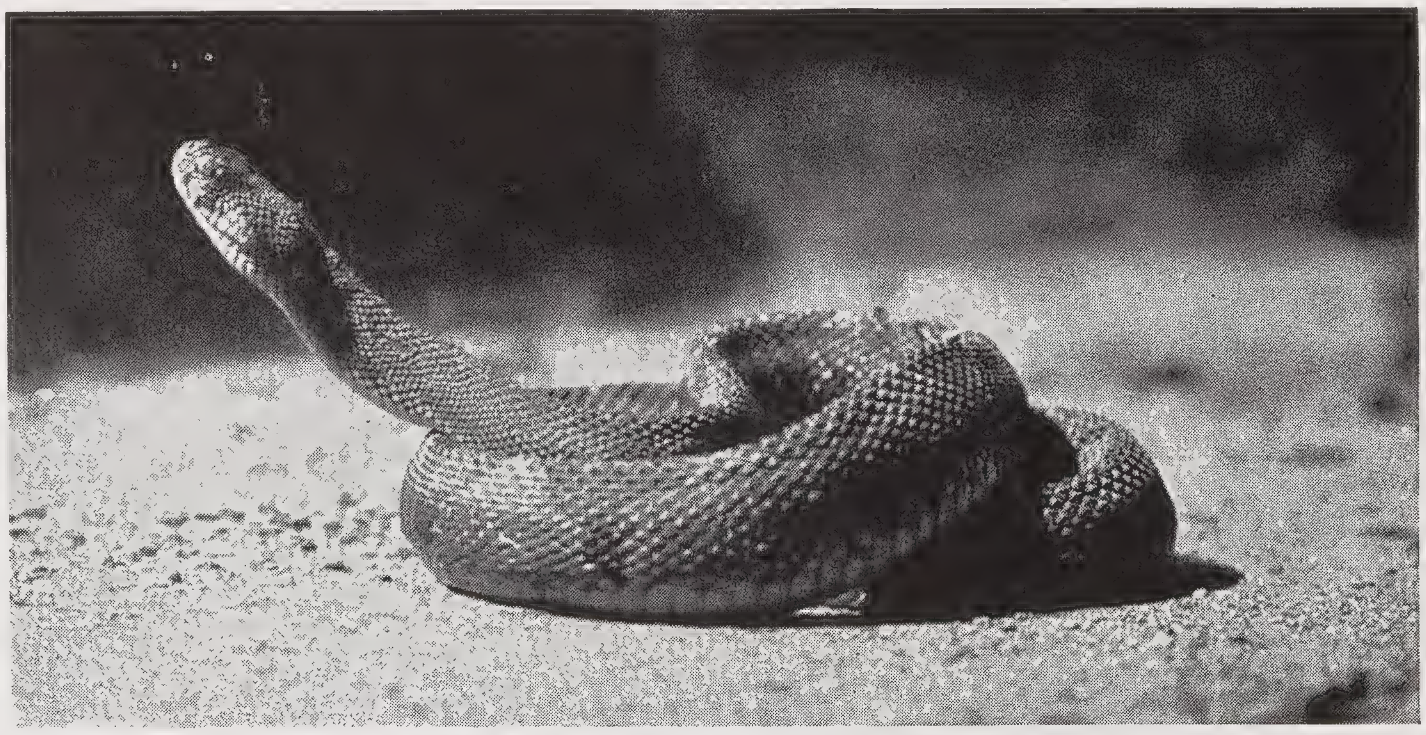
Consequently, during the past summer, the Curator of Mammals and Reptiles selected as an area of reconnoiter the island of Trinidad, which in its fauna is similar to the South American mainland in the latitude of Venezuela. There was delay in departure, and Arthur M. Greenhall, student at the University of Michigan, went on several weeks ahead. Before the Curator arrived in Trinidad, Greenhall had obtained and quartered in a screened house on the experimental grounds of the Imperial College of Tropical Agriculture, four specimens of Vampire Bats, which represented a different subspecies from the Panama form. When the Curator arrived, he spent a number of evenings watching these bats in the dim light of a lantern and he noted that all the actions of the first specimen were precisely duplicated.

The four vampires were successfully brought back to the Zoological Park and here a special cage, in which they might fly and otherwise exercise, was constructed. The cage is fronted with a long plate glass panel to provide facilities for the best possible photographic records.

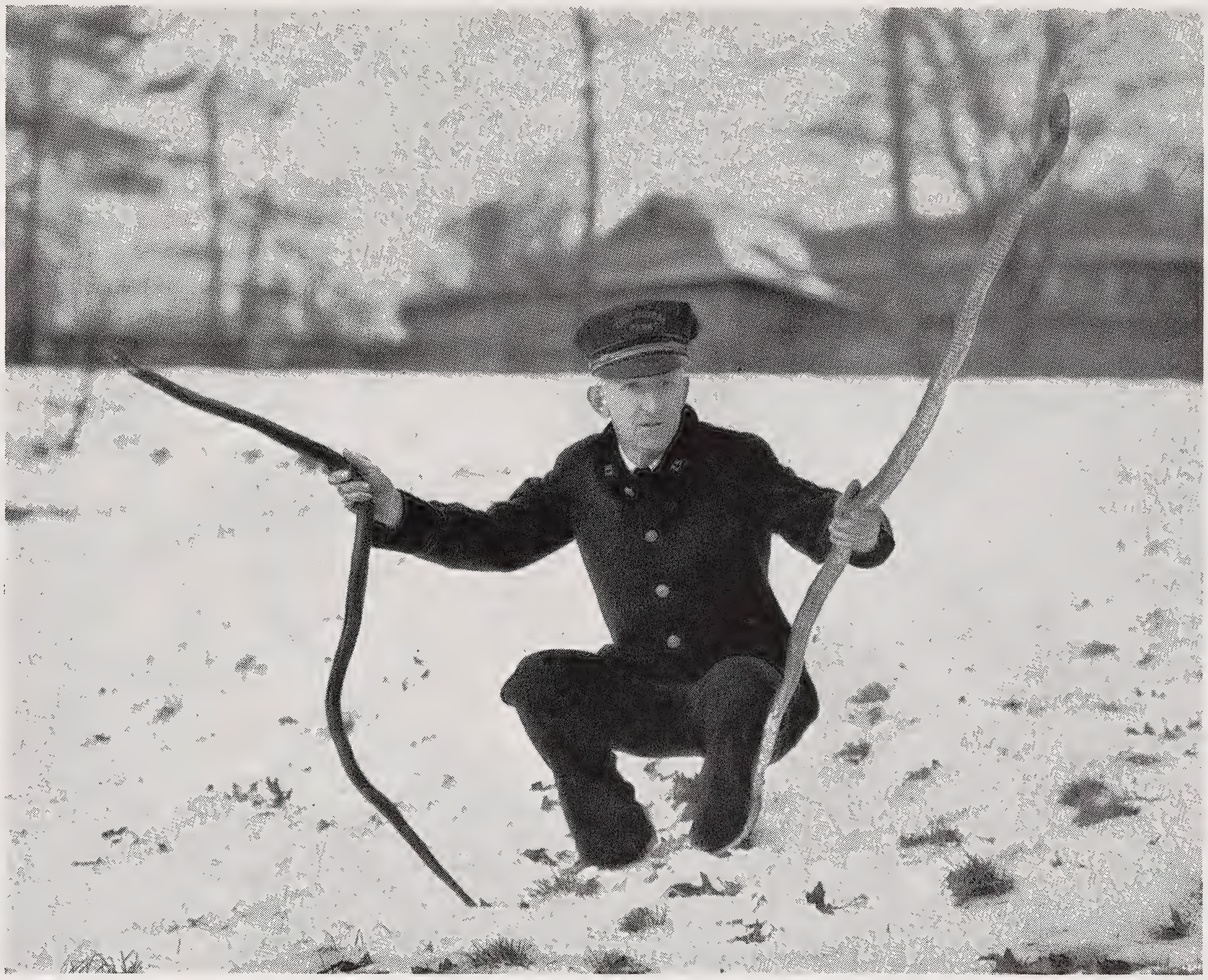
In this cage the bats were gradually introduced to brighter light and finally it was possible to produce motion picture records of vampires captured about 700 miles from the source of the first one. These demonstrated in every way that the Curator's assertion that habits of the Vampire Bat, up to the time of observation of the Panama specimen, had been incorrectly or misleadingly described, and much that was new had been brought out. The motion picture records thus have been made very complete and stand as unique and of considerable value.

It is not only for the interest of exhibiting the Vampire Bat and recording its strange habits that this work has been done. The Curator is collaborating with two phases of investigation going on respectively at the Gorgas Memorial Laboratory at Panama under the direction of Dr. Herbert C. Clark and the work of a scientific commission with which Professor F. W. Urich is associated on the island of Trinidad. Both phases of research are of high importance as they relate to certain vampires carrying the organisms of disease. In Panama it has been carefully checked and conclusively proved that the vampire is a vector, or transmitting agent, of a trypanosome which lives in the blood of cattle, which are resistant to it, but when transferred to horses quickly produces a fatal result. Fortunately, this organism will not live in human blood. As vampires during their nightly flights may bite infected cattle on one occasion and on the next attack a horse, the spread of this tropical disease, called "murrina," is a serious problem. Through the study of the vampires at the Park it is hoped to determine their length of life, the amount of fluid nourishment they requre, their periods of feeding, and other habits. These investigations are of benefit to Dr. Clark in expanding his work. They similarly help Professor Urich in Trinidad, where an even more serious problem is being worked out, relating to vampires as the agents in transmitting paralytic rabies, which, as so far demonstrated, is fatal to all types of victims that are bitten.

Another phase of investigation now under way



From This Coiled Position the Bushmaster *(Lachesis muta)* Can Throw His Head Forward in a Lightning Stroke Attack. The Picture Clearly Shows the Rough Texture of His Skin From Which He Gets His Native Name of "Mapipire z'Anana," the "Pineapple Snake."



During One of the Coldest of the January Cold Spells, a Shipment of a Dozen Gopher Snakes Arrived at the Park from Brownsville, Texas, and in the Brief Time it Required an Express Company to Transport Them from Lower Manhattan to the Bronx, All Twelve Were Frozen Stiff. Thawed Out in Front of a Radiator, Six Recovered and Showed No Ill Effects from the Accidental Refrigeration. This Picture Shows Two of the Snakes When They Arrived.

at the Park includes experiments to determine whether the Vampire Bat carries an anticoagulant in its saliva, which, carried to a wound by the lapping tongue, induces prolonged bleeding after a vampire bite. Certain it is that the wounds produced by these bats may bleed for a long time after the bat has gone. This is another matter to be solved in assisting in the work of the scientists in the tropics. Dr. Barry King, of Columbia University, is now engaged in this research. R. L. D.

The Bushmaster

The Bushmaster, brought up from Trinidad the past summer, died about three months after arrival in the Park. This serpent gained considerable renown, as the species is elusive and difficult to capture. Only three other specimens have been exhibited during the thirty-five years since the opening of the Park, and there was a gap of nearly twenty years preceding last summer's arrival.

As an adult Bushmaster had never been known to take food in captivity—a circumstance that checked with other individuals and institutions that had attempted to handle them—it was decided to force-feed our specimen every week in an endeavor to keep it strong and get it accustomed to captive conditions.

Since the specimen was only six feet long and young, the process of pinning down its head, grasping it by the neck and forcing a freshly killed rat into its mouth was not difficult. Happily, the serpent took rather good-naturedly to the operation and immediately finished the process by swallowing the rat without further urging.

Soon after the snake arrived it was noticed that it was having difficulty with its old skin and cage temperature and moisture were carefully regulated to approximate tropical forest conditions. To our surprise and gratification, the snake shed its skin quite successfully and emerged blooming and vivid in a pattern of pinkish brown with broad cross-bands of black.

Two months later, after a regular diet of force-fed rats and young rabbits, it apparently had improved in condition, and it shed its skin again.

We were thus rather shocked three months after the serpent's arrival to find it dead in its cage one morning. Headkeeper John Toomey announced the event with the same lack of emotion that greets all the discoveries he makes around the Reptile House—the birth of a baby Vampire Bat on one occasion, the death of a famous old alligator on another.

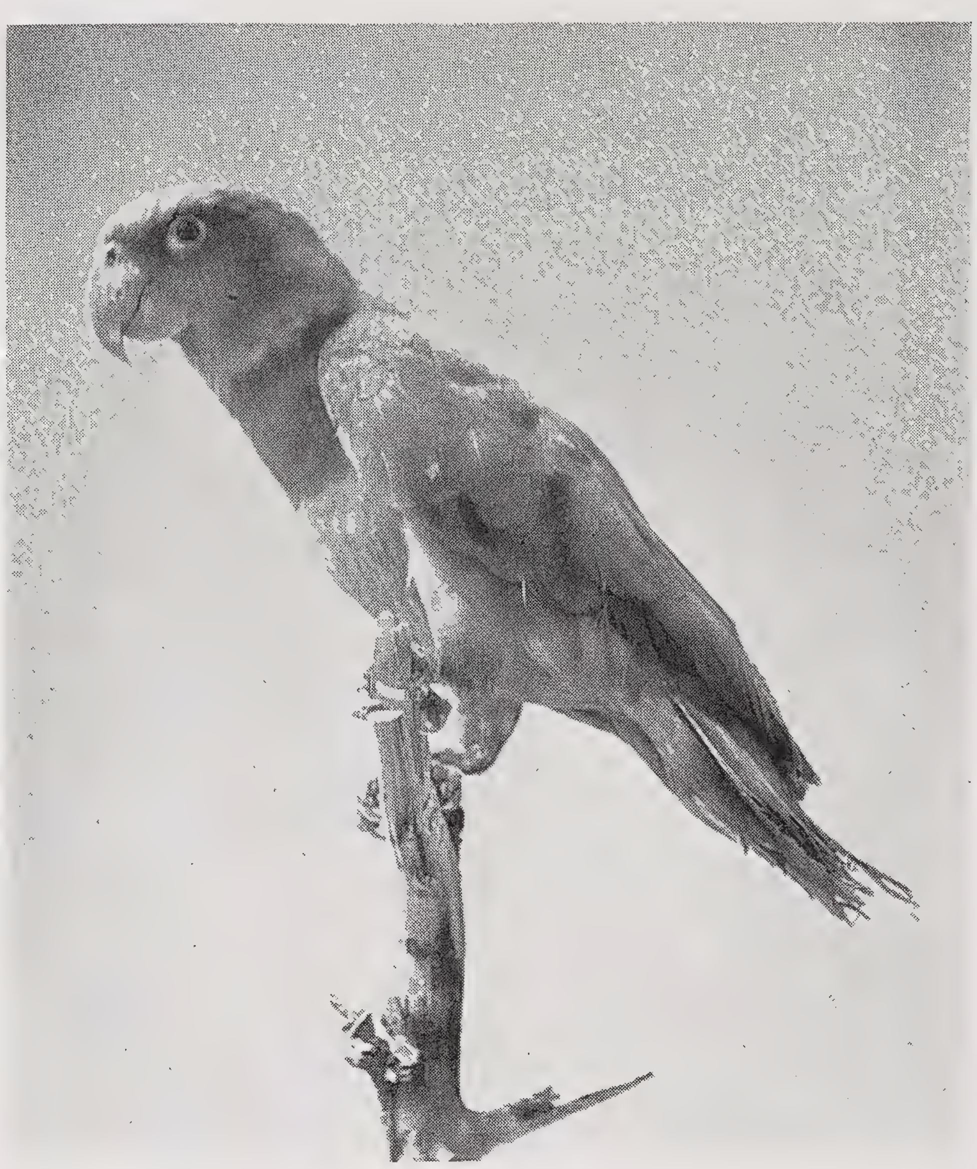
Dr. Noback performed an autopsy that disclosed that the snake was heavily infested with several kinds of parasites—so many and so well developed that he had obviously carried them with him when he was brought back from Trinidad. A more complete discussion of the parasites—with their interesting life cycle passed partly in the rats upon which the Bushmaster feeds—will be found in Dr. Noback's section of the Annual Report of the Society.

This Bushmaster aroused so much interest that various collectors in the tropics went in search of the species. Simultaneous efforts broke out in Panama, Colombia, Dutch Guiana, and Trinidad. In consequence, by late fall of the past year, three additional Bushmasters had been distributed respectively to the Reptile Houses at St. Louis, Philadelphia, and Washington. At this writing, all have died, without any inclination among any of them to take food voluntarily. R. L. D.

No Beauty, But—

During the past five years, severe restrictions concerning the importation of parrots into the United States have been enforced by the Federal health authorities. There may be some latitude where the bird is a pet and is accompanied by its owner, but dealers' shipments must spend two weeks in quarantine, under government supervision. During this period, there must be no deaths, or the consignment is not released.

Under this system, a few parrots of the more common, teachable species are imported, usually in lots of 100. But for small shipments of the rarer kinds, the cost is prohibitive, so that practically none are brought in. The birds of the parrot group are noted for their hardiness and willingness to live when properly cared for. However, they are not immortal and the shortage is beginning to be felt by our own institution as well as by others of its kind. Consequently, we experience a feeling of jubilation when something out of the ordinary appears, even though it may once have been fairly common.



No Beauty—But Hard to Get. This Is the Lesser Vasa Parrot *(Coracopsis nigra)* Recently Added to the Park's Bird Collection.

The Lesser Vasa Parrot (*Coracopsis nigra*) never was a really common bird, but specimens were usually obtainable from time to time. It is, however, not noted for its talking ability and there seem to have been no importations since the quarantine restrictions went into effect. In fact, our last specimen was obtained in October, 1923. When this bird died, in 1929, there was good reason to suppose that it would soon be replaced, but the Federal regulations appeared to write *finis* to our expectations.

The unexpected is a potent factor where collections of living animals are concerned, and something of the sort occurred to relieve the Vasa Parrot situation. A bird lover, somewhere in the Middle West, decided that she could no longer keep the pet Vasa she had had for some years. She prevailed upon her local bird dealer to take it in exchange and he, in turn, sent it to a New York dealer, on a similar basis. On its arrival here, we examined the bird, found it in excellent condition, and bought it for a moderate sum.

Wild caught Vasas are so very shy and timid that it is difficult to gain their confidence, but hand-reared ones are charmingly tame if sympathetically treated. Our bird belongs to the latter group and is delightfully quiet and steady.

There are five kinds of Vasa Parrots, two occurring in Madagascar and the others in the nearby Seychelles and Comoros. All are colored in a shade found in no other group of true parrots; a dull, brownish black. The Lesser Vasa is not a bird of beauty, nor is he a gifted linguist, but he makes up in rarity for what he lacks in other respects. L. S. C.

Animals on the Curriculum

During the past month the Department of Educational Activities, in co-operation with the American Institute, conducted a series of lecture-demonstrations at the Park.

Four Saturday mornings were given over to members of the Junior Science Clubs from various public schools, junior high schools and high schools of the city. Two different groups were represented, the boys and girls composing them being chosen by the Institute, and that organization sponsored the two courses and made all arrangements for attendance. Both courses proved to be very popular and, following a preliminary announcement, it was found necessary to limit the registration for each session to 30 pupils. The final attendance was exceptionally good and practically the full list of registrants showed up for the meetings, despite cold and rainy weather.

The first two sessions, for the Junior members, were offered as a course in the "Care of Wild Animals in Captivity." Under the guidance of the Curator, this group visited the Reptile House, Small Mammal House, the Chef's headquarters, and the Hospital. In each building the club members were brought in direct contact with some of our Park animals and observed food materials in preparation. At the same time they participated in an informal discussion and demonstration of the numerous requirements for maintaining wild animals in a comfortable state of captivity.

On the following two Saturdays a Senior Science group attended the course entitled a "Study of Wild Animals." Although much of the work done during the previous two weeks was repeated for this course, special attention was paid to the characteristics of various animal groups, especially those involved in classification and in demonstrating relationships.

All the members of these courses enjoyed a more intimate contact with wild animals than they had ever experienced before. This was the direct inspiration for numerous interesting and intelligent questions concerning animal life, and many expressed their regret that the sessions could not be extended over a longer period.

Meetings such as these do a great deal toward creating a sympathetic interest in animal life. The Department offers a similar service to all school groups and a number of classes have already been scheduled for the coming year. C. W. L.

Newcomers in the Cages

Shipments of mammals during the fall and winter were, as usual, few. However, the arrival of two Spectacled Bears from South America is to be noted. These were cubs, now thriving and growing. The species is of particular interest as it is the only bear found anywhere in South America. When adult, it is similar to a medium-sized North American Black Bear and characterized by white "spectacle" markings around the eyes—whence its name. It occurs only in the mountains of Peru and Colombia. Another accession among the mammals is a fine young Bengal Tiger.

A number of reptiles have been received. Among these are specimens of the Giant Anolis or Cuban "chameleon," African Chameleons, Tegus from Demarara, South American "two-headed" lizards and the big yellow and black poisonous lizard from Mexico which is allied to the Gila Monster.

Among the snakes there has been a variety of small, brightly-colored species from the American tropics, including a dwarf and degenerate ally of the boas, which lives in ant hills. This curious creature is deceptive when one tries to recognize its extremities at first glance. Its head and stubby tail are almost precisely matched in outline. Moreover, it usually glides with the head flat to the ground and the tail well reared. Its pattern is extremely handsome—ringed with coral-red and lustrous blue-black, symmetrically spaced. On the ground it looks more like a gaudy necklace than an actual reptile. R. L. D.

Guests of the Park

During the winter months, when wild bird visitors to the Zoological Park are less numerous than in summer, our attention is considerably occupied by ducks. Few people, aside from sportsmen and naturalists, realize that many thousands of wild fowl pass the cold weather within a few miles of New York. The shallow waters along the shores of Long Island and the numerous rivers flowing into the Sound make ideal feeding grounds for the hosts of ducks that frequent them.

During mild or even normal winters, there appears to be an abundance of food and the visiting flocks seem to thrive. But when there is excessive cold and heavy falls of snow are frequent, as during the winter of 1933-1934, the rivers are likely to freeze over and ice may form along the shores of brackish waters. Then the ducks are forced into deeper water to avoid being frozen in, and here they cannot reach the bottom for food. Last winter, the wild flocks suffered heavily and each of the many severe storms took its toll. Hundreds of dead birds were strewn upon the nearby beaches, to become the prey of swarming herring gulls. Rafts of starving ducks floated on the waters of the East River as far South as Clason Point, too far from shore to be enticed by proffered grain.

When too weakened by hunger to offer further resistance, many of the birds floated in and crept upon the ice along the shore. Most were too near death to survive for long, but a few were picked up by chance and brought to us. If there had not been too much delay, they usually fed at once, and many survived. These were mostly Greater Scaup but among them was a lovely male Canvasback, dug from a snowbank at Clason Point, where this species is rarely seen. A male Lesser Scaup was picked up in Burnside Avenue, in the Bronx. This bird, no doubt, had fallen exhausted from a passing flock seeking more friendly waters.

Up to the middle of January, at least, the present winter was marked by the absence of severe storms and extreme cold, so that ducks, in general, should have had a fairly good time of it. Undoubtedly they did, for the most part, but a flock of Greater Scaup, wintering in the East River, did not fare so well. Early in January, two boys brought us a female, picked up on the Bronx shore near Old Ferry Point. She was very light, the feathers of her abdomen matted with oil. Her rescuers reported that there were "plenty more" and volunteered to bring us a male, which they did the same day. A few days later, a second male was retrieved by another party of explorers. All of these birds responded promptly to an abundance of food and the removal of the threat of pneumonia, which frequently results when the insulating property of feathers has been reduced by oil.

The problem of floating oil, as an agent of destruction of bird life, is world wide, of course, and has received much attention from conservationists and others. It appears, however, that this is just another source of pollution of the local waters of New York, and is not likely to be completely eradicated. If this is true, then the wintering of ducks in and near New York will soon be a thing of the past.

While the arrival of these stricken birds at the Zoological Park always occasions a wave of interest and solicitude, it is the hordes that come of their own volition that bring with them a real problem. There was a time when visiting water fowl were both scarce and welcome. As far back as 1900, seven Canada Geese were captured from a flock of nine that had been decoyed by the captive birds on Lake Agassiz. From that time on, a few ducks, mostly Blacks and Mallards, have dropped into our lakes during migrations. For many years, their numbers were hardly noticeable, but gradually the crowd has increased until, during the past four or five winters, as many as a thousand have added themselves to our own flocks. At first, they were likely to move on after sampling our grain; now they find it so entirely palatable that they spend the winter. The season of 1933-1934, per-

Friends of the Park Whose Visits Have Become a Habit—Part of the Flock of 600 to 700 Black Ducks, 200 Mallards, and a Scattered Few Green-winged Teal, Pin-tails and Bald-pates Who Are Spending the Winter on the Wildfowl Pond Where They Can Be Sure of Regular Meals at No Trouble to Themselves.

haps because of severe conditions, marked the high spot. This winter we seem to be entertaining from 600 to 700 Black Ducks, with perhaps 200 Mallards and a smattering of Green-winged Teal, Pintails, and Bald-pates.

The problem of food for these birds is no small matter. They require from 100 to 150 pounds daily—they like a little extra when the temperature is low! Our own ducks are fed largely on a grain mixture known as scratch food, and at first we simply increased the allowance when the visitors arrived. This soon proved too expensive, however, and now all have to be content with western corn, the cheapest suitable grain we have been able to find.

L. S. C.

Books of Interest

Half Mile Down. By William Beebe, Director of the Department of Tropical Research of the New York Zoological Society. Published under the auspices of the Society. 344 pp., with 123 illustrations and 8 colored plates. Harcourt, Brace & Co., New York, 1934. $5.

Dr. Beebe's deep sea exploration in the bathysphere built by Otis Barton in 1929 has been reported from time to time in the Bulletin, but it seems that despite all the technical and public interest in his adventure, not even the half has been told heretofore. Much that is new—impressions, observations, descriptions of the technique of working in a bathysphere—remained to be developed more fully and attained expression in the present volume published under the auspices of the Zoological Society.

For that matter, it is not likely that the half can ever be told of such an experience as a descent more than half a mile into the cold, eternally black depths of the ocean. One can do it, and then talk about it and write about it indefinitely, and still the kernel of the experience is elusive. To depart only half a mile from other human beings, and yet to be where no others of your kind have ever been—alive—is one of those simple facts that hold infinite possibilities for the imagination.

Dr. Beebe makes the most of the imaginative possibilities of his adventure in "Half Mile Down," but he also has added, fragmentarily, it is true, to objective human knowledge of a world that heretofore seemed cut off by impassable barriers.

His researches into the history of diving lead him to the inference that as early as 4500 B.C. men must have been in possession of some means of working under water to procure mother-of-pearl. Thus there are more than 6,000 years of history behind the bathysphere, and many were the attacks made on the problem of descending into the depths and returning alive, although few, it must be confessed, were undertaken for as disinterested a purpose as the observation and study of deep-sea life.

Alexander the Great is supposed to have descended in a glass cage, to look at fish, and was rewarded for his initiative by observing one that took three days to swim past. Dr. Beebe was not so fortunate; he did, indeed, observe some large, shadowy forms but they were too indistinct for any such account as Alexander presumably gave, and there were enough minute wonders clearly visible to satisfy him.

The bathysphere was put into operation in Bermuda waters in 1930 and a depth of 1,426 feet was reached—a depth that seemed sufficiently great in those early experimental days when the underwater observers realized that at a quarter of a mile, the pressure upon the bathysphere was more than six and a half million pounds.

The next year took them below 1,700 feet, the utmost limit of light from the surface, to 2,200 feet. The following year the same depth was attained, and it was on Dive Number 32, on August 15, 1934, that the ultimate depth of 3,028 feet was touched by Dr. Beebe and Mr. Barton.

Dr. Beebe's accumulated observations at varying depths have made some definite contributions to knowledge of the abundance and kind of life deep in the ocean, and have raised more problems that may never be solved until super-bathyspheres are built. He saw sea creatures that no other human being has ever seen, and he saw them distinctly enough to instruct artists in the preparation of drawings; some he even named, on the strength of his brief observation. Such a practice is, perhaps, not in accordance with the standard scientific method, but it is the pioneer's privilege, and after 6,000 years of diving, Dr. Beebe is still a pioneer.

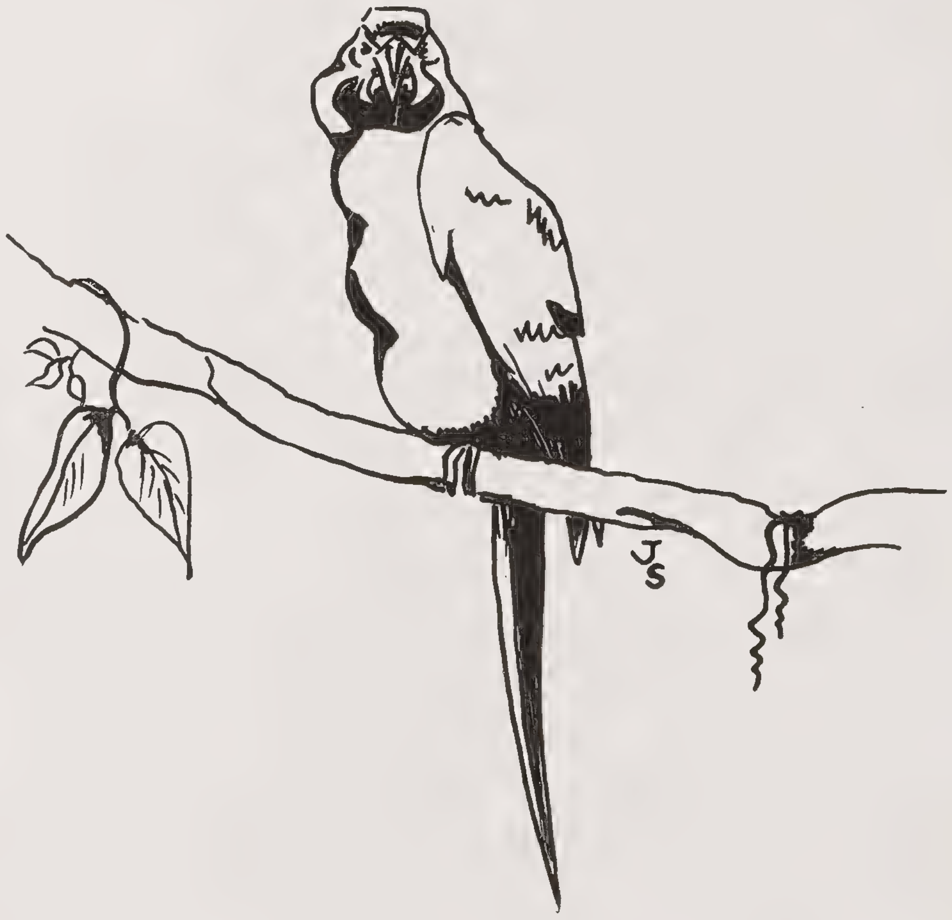
CONFESSIONS OF A SCIENTIST. By Raymond L. Ditmars, Curator of Mammals and Reptiles at the New York Zoological Park. 241 pp., with 39 illustrations. The Macmillan Company, New York, 1934. $3.50.

The Curator of Mammals and Reptiles of a populous institution such as the Zoological Park inevitably, in the normal course of his working day, leads a busy and sometimes adventurous life. If he spends his vacations busily hunting more adventures, as Dr. Ditmars does, his year is likely to be very, very full.

Some of the things that have happened to him are recounted by Dr. Ditmars in "Confessions of a Scientist." His own interest obviously centers strongly around his research into the natural history of the Vampire Bat, the first specimen of which he brought back from Panama in the autumn of 1933, augmenting his research facilities with four specimens from Trinidad in the past summer.

He tells of snake hunting trips to the tropics and it must be counted as a confession that on one such expedition, to Panama, the only snake he saw during the whole journey was—aboard the boat when he sailed for home! Somehow a baby Boa Constrictor found its way into the cabin of the ship's doctor.

"Confessions of a Scientist" is a medly of observations and comments on experiments with animal photography, field work at home and abroad, the handling of animals and reptiles in the Zoological Park, the perennial interest that animals have for the newspaper-reading public, the part that some of Dr. Ditmars' charges—certain reptiles—have played in the treatment of cancer and hemorrhage. Many of the matters of which he treats have been mirrored in the day's news and "Confessions of a Scientist" is in the nature of the ever-interesting "inside story."



PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-VI and Volume VIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Published by the Society

Heads and Horns Brochure: A picture catalogue of the collections in the Heads and Horns Museum. Numbers 1 and 2 are completed, but publication is temporarily discontinued. $1. (16 *oz.*)

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Fishes in the Home (*Mellen*). 178 pp.; 63 illus. $1.10.

The Public Aquarium (*Townsend*). 97 pp.; 47 illus. 85c.

Color Changes of Fishes (*Townsend*). 58 pp.; 11 text figs.; 27 color plates. $1.10.

The Fur Seal of the California Islands (*Townsend*). 8 pp.; 11 text figs.; 1 color plate. 75c.

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Tropical Fishes as Pets (*Coates*). 226 pp.; 56 illus. $2.50.

Postcards: General Exhibits. Set of 12, colored. 35c.

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For all Aquarium publications or any work relating to aquatic life, address the New York Aquarium, Battery Park, New York City.

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A classified list of the publications of the Society, with subject headings of articles printed in the *Reports, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. MITCHELL, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

Clark and Fritts, New York, Printers.

THE NEW YORK ZOOLOGICAL SOCIETY

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

SMITHSONIAN INSTITUTION
APR 3 1935
NATIONAL MUSEUM

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EVER since its founding in 1895 the New York Zoological Society has attracted the active interest of persons who believe, with the founding group, that instruction and entertainment and important scientific achievement can go hand in hand through the maintenance in New York City of well-balanced collections of mammals, reptiles, birds and fishes from all parts of the world.

In the Society's work of gathering, maintaining and exhibiting its collections, as well as its constant efforts in behalf of conservation of wild life everywhere, every Member shares, and through the privileges of Membership and the Society's publications is rendered an accounting of the work in which he participates.

The New York Zoological Society invites the Membership of all persons who wish to lend financial support to the purposes for which the Society was founded and to cooperate in a tangible way toward the future development of the Zoological Park and the Aquarium.

Annual Membership in the Society is $10, renewable annually. Life Membership may be obtained for $200. A contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

All classes of Members are entitled to receive every periodical publication, the privileges of the Administration Building with its lounges and reception rooms and gallery of paintings of animals, to attend lectures, open meetings and entertainments, and to be admitted free to the Zoological Park and the Aquarium every day in the year.

Application for Membership may be given to the Director of the Zoological Park or the Director of the Aquarium, or may be mailed directly to the Secretary, 101 Park Avenue, New York City, for action by the Executive Committee.

The Zoological Park is open every day in the year from 10 o'clock in the morning to one-half hour before sunset. Admission is free every day except on Mondays and Thursdays when an admission fee of 25 cents is charged for adults and 15 cents for children between the ages of five and twelve. These days have been set aside primarily for the benefit of Members and their friends, who are admitted free on tickets issued with Membership, so that the collections may be seen to the best advantage. All holidays are free.

The Aquarium also is open every day in the year. From April 1 to September 30 its hours are 9 o'clock in the morning to 5 o'clock in the afternoon, and for the remainder of the year, from 9 A. M. to 4 P. M. No admission charged.

Thirty years ago this spring a National Collection of Heads and Horns was a vague dream. In 1922 this Museum turned the dream into reality and it stands today in the Zoological Park as a permanent memorial to the vanishing big game of the world.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY
Published by the New York Zoological Society

Vol. XXXVIII March-April, 1935 No. 2

The National Collection of Heads and Horns

Some Notes on a Dream that Became an Institution

William Bridges
Editor and Curator of Publications

MAN the Hunter has killed big game for centuries and carried home the horns and heads and antlers and tusks as trophies of his chase. He has decorated the walls of smoking rooms and hunting lodges, palaces and museums and clubs, with the finest evidences of his skill and daring. And yet, for all his pride of possession and centuries of collecting, he has evolved no other such exhibit as the National Collection of Heads and Horns here in the New York Zoological Park.

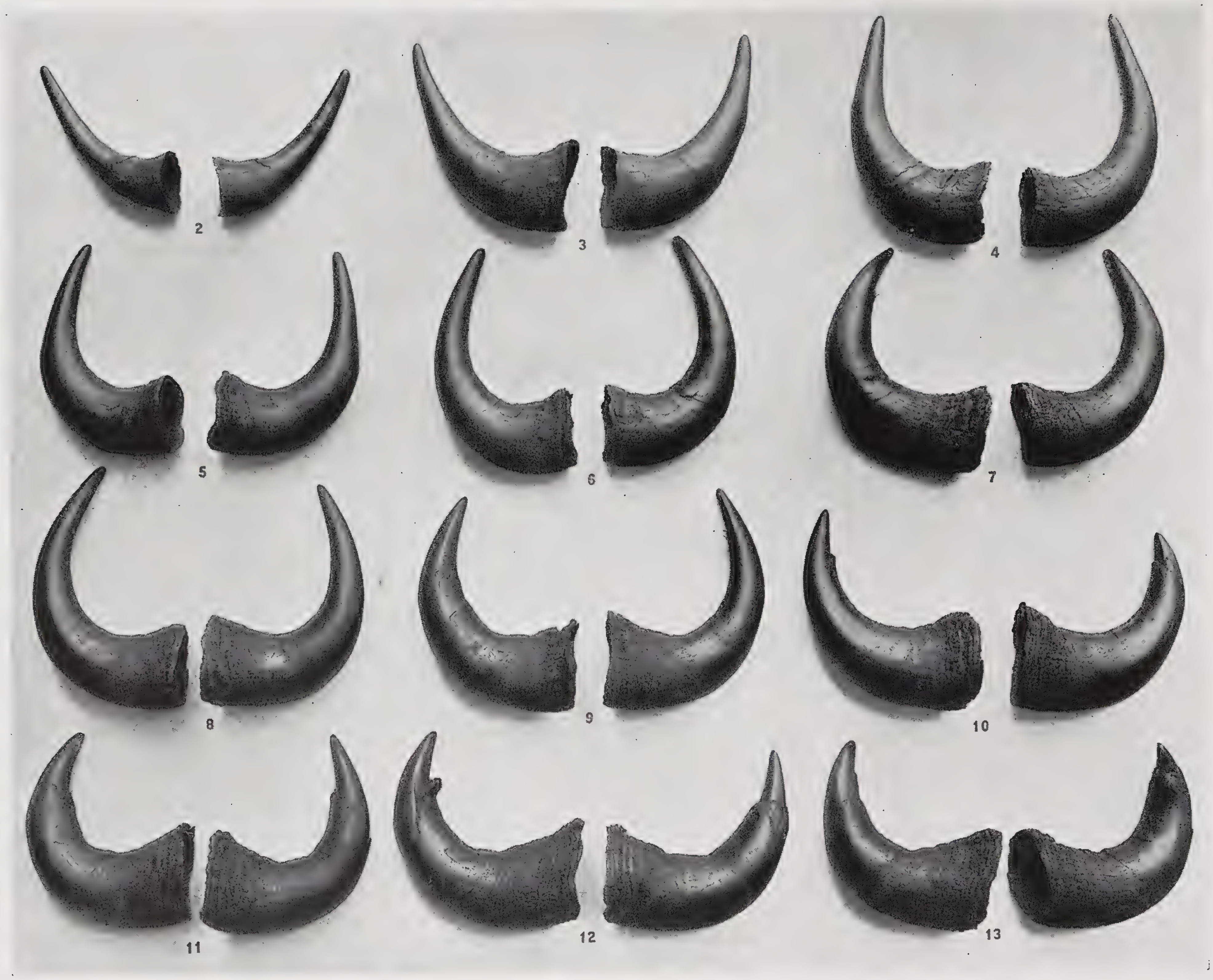
That collection is unique. Up to now there is nothing like it anywhere else in the world. At a rough estimate, which is all that is possible, the collection is worth $500,000, but it is not the money value that makes duplication in any other city or country doubtful; it is the actual disappearance from the face of the earth of surpassing specimens of species now going down and out.

This article is an attempt to tell briefly and yet with some interesting detail how the National Collection came into being and how it has grown from a dream, an idea, into an institution that has attracted the active and enthusiastic support of sportsmen all over the world. The present curator of the collection estimates that two-thirds of the visitors to the Zoological Park visit the museum; which means that 1,500,000 to 2,000,000 persons every year enter the doors of the low, beautifully proportioned building on Baird Court and leave it, inevitably, with eyes opened to the richness of the horned and hoofed fauna of the world, the amazingly wide distribution of families and the extremes of specialization in weapons of defence.

Standing the Zoological Hall, the visitor can encompass in one cycloramic view practically all the big game species of the world. For purposes of comparison and the tracing of superficial relationship, there is no collection anywhere else that affords such opportunities.

The basic idea of such a collection began to take form in the mind of Dr. William T. Hornaday thirty years ago this spring. As a sportsman and naturalist he had been called on to inspect the hunting trophies of hundreds of men. As a guest in their homes he had been shown the heads and horns that represented their owners' dearest pride—the trophies of their own shooting. Sometimes he saw good collections of one or two species, made up of indifferent or good or poor specimens; whatever the hunter had managed to acquire by his own gun. Rarely, if ever, did he find a private collection resting on a broader and more systematic base, such as he as a scientist could recognize as anything more than evidence of the hunter's pride.

A magazine article was the outcome of his long experience with heads and horns collections. Based on his own systematic collection and published in *Scribner's* in the fall of 1905, it undertook to educate the general reader and show him how interesting a really broad collection could be. He wrote of the futility of con-



A series of American bison horns collected by Dr. Hornaday on the Montana bison range in 1886 *and presented to the National Collection. It shows the horn development from that of a yearling bull to a twenty-year old "stub-horn."*

fining a collection to the products of one's own shooting and he decried the egotistical impulse that caused sportsmen to ignore the fine heads, the typical heads, of any animals they had not personally shot.

In a way, he was appealing to the sportsman to form in a small way such a collection as the National Collection has become. Obviously an all-inclusive exhibition of the hoofed and horned game of the world was impossible for the private collector, or virtually so, but a widened range of interest to include representative species of several continents was not impossible. He could cite his own collection—small, perhaps, but truly representative of the big game of many parts of the world. None of it, or practically none, had he shot himself, because all of his own best gatherings had gone into museums.

Nowhere in the article was there any suggestion of a National Collection which should be, on a grand scale, what he was proposing for private collectors. Whether the seed began to grow in their minds, he does not know, but it turned his thoughts in another direction.

What about his own collection? What was he going to do with it? How eventually should he dispose of it? What could other men do with similar enlarged collections if they took his advice and collected in many fields?

His own family, Dr. Hornaday considered, might not want to keep up the collection and add to it. He, personally, felt that he would not like for it to be broken up and sold.

All those thoughts and considerations began slowly to crystallize, and there came a time a few months later when he made up his mind what he wanted. He wanted some central depository, some institutional trust, for his own collection and the collections of other sportsmen, where the finest trophies might find a permanent home and the systematic plan he had written about might be worked out on a grand scale!

Such a depository would be, in essence and fact, a national collection of heads and horns.

In his own mind he worked out some of the details and then he mentioned his plan to Mr. Madison Grant, the chief executive officer of the Zoological Society. The response was immediate and enthusiastic:

"Fine!" said Mr. Grant.

Together they thought the thing through, considered the support it might gain from sportsmen, and laid the groundwork of a collection they would like to see established. As Secretary of the Zoological Society, Mr. Grant sponsored the proposal before the Executive Committeee and gained its backing. Late in 1906 the Zoological Society told the founders to go ahead and to approach the country's sportsmen with the understanding that the Society would receive a national collection if it could be formed, suitably install it, and permanently maintain it.

With Mr. John M. Phillips of Pittsburgh, president of the Lewis and Clark Club, who acted as a liaison with the sportsmen, Mr. Grant for the Boone and Crockett Club and Dr. Hornaday for the Camp-Fire Club addressed a prospectus to the Sportsmen of America on March 20, 1907, and set forth exactly what they wanted:

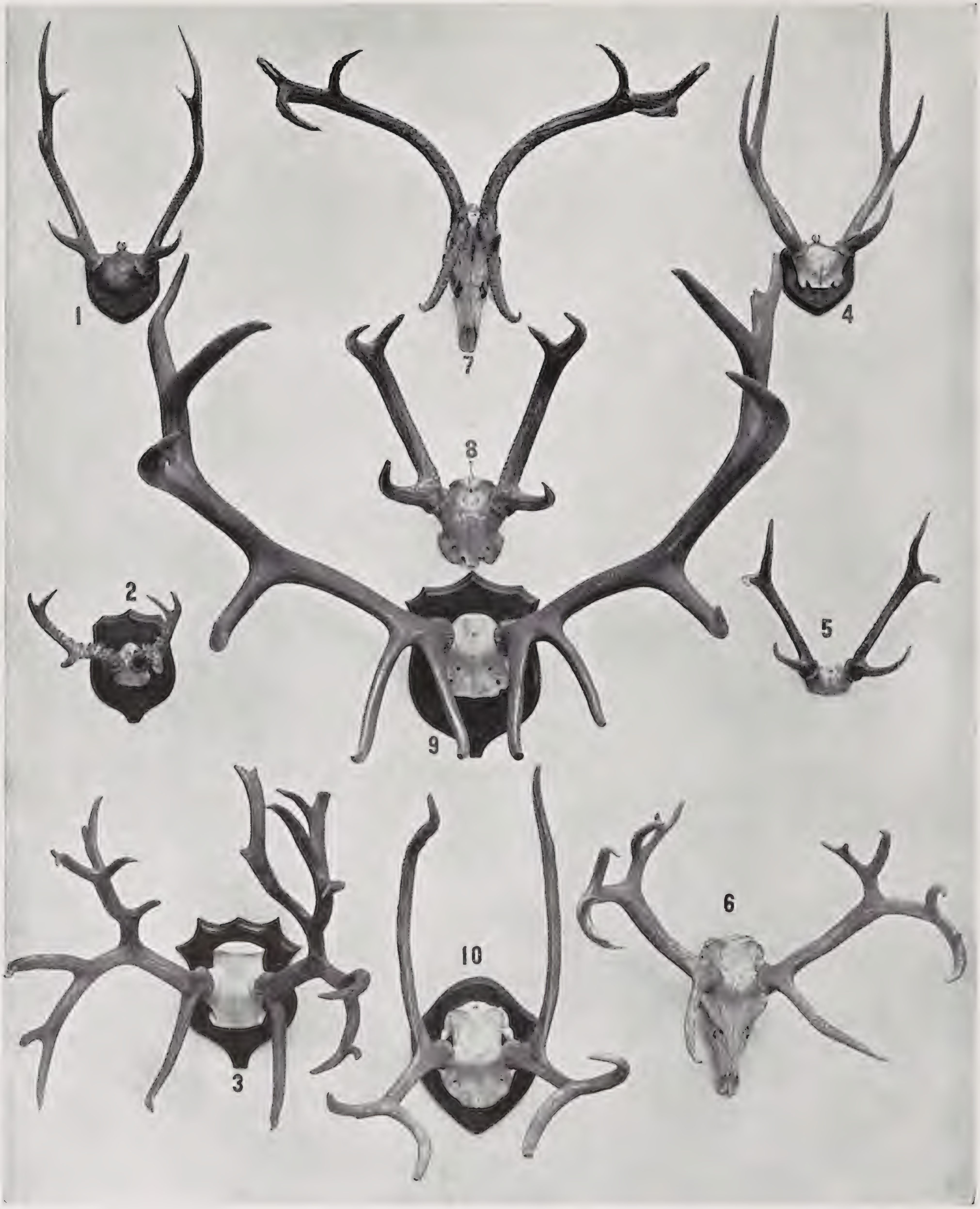
". . . a depository for the finest wild-animal trophies which it is possible to bring together . . . accessible, spacious, fireproof, well-lighted, finely appointed in every detail, and managed by sportsmen. . . . There should be formed a zoological series and a geographical series—by continents—each as nearly complete as it can be made."

Close on the heels of that prospectus came an announcement, dated May 1, 1907, that the thing had been done: the National Collection of Heads and Horns was already an actuality. Dr. Hornaday had presented the institution with his own collection—the Nucleus Collection, as he called it in the handsome brochure that followed the prospectus.

The whole plan of procedure was new. Up to that time, no attempt had been made, even by scientific institutions, to form a systematic collection which could be arranged to show a student or naturalist or sportsman, on the space of a few walls, the zoological relationships of species and the characteristic forms of the horns and antlers of the world's big game. The mere size of collections already in existence mattered very little. Abroad there were tremendous collections in private hands, but usually the species represented were extremely limited. Nor were the choicer and more selective collections of individuals, or of most of the world's museums of natural history, in much better case. They were all incomplete, usually scattered through many halls, or overburdened with freaks, or broken up into special exhibits designed to show particular traits.

THAT was not what the founders of the National Collection wanted. "It is natural," Dr. Hornaday wrote in that first brochure, in which he described his Nucleus Collection and set out the plan of the National Collection more in detail, "it is natural for one who is interested in a special group of animal forms to desire a collection which in one way or another will represent its members. Of groups which embrace only small-sized individuals, it is often possible for one man to possess a large assortment of species and individuals. But in the gratification of a taste involving individuals of large bulk, the limitations are many and severe. With such important forms as the hoofed mammals of the world, it is not desirable that many men should be animated by the desire for large collections. The undue gratification of too widespread a desire for heads and horns, irrespective of their origin, would mean great and deplorable slaughter 'for commercial purposes.'

"In America, museums generally are treating the order *Ungulata* merely as an integral part of the great living world, which is not to be unduly exploited at the expense of other zoological groups of equal scientific importance. In the zoological parks and gardens, the limitations upon the collections of hoofed animals are numerous, and it is possible to procure and exhibit only a few representative species, which as far as possible must typify the whole vast series.



Round-horned Deer Antlers in the Nucleus Collection

1. *Japanese sika deer.*
2. *Siberian roe.*
3. *Schomburgk's deer.*
4. *Hog deer.*
5. *Luzon sambar.*
6. *Barasingha deer.*
7. *Thameng.*
8. *Malay sambar.*
9. *Altai wapiti.*
10. *Père David's deer.*

"Nevertheless, the desire to behold complete collections of large-game specimens springs eternal in the human breast. The wish for a comprehensive and all-embracing exhibit of the world's horn-bearing animals is both natural and legitimate. To us, the logical sequence of the situation is a national collection of heads and horns, as fine and as nearly complete as American sportsmen and travelers can make it, located in the New York Zoological Park and owned and maintained in perpetuity by the New York Zoological Society.

"There should be two series of specimens, both of which eventually should be made complete. The first should be zoological, the second geographical, and each should command an abundance of space. The first should be arranged in accordance with the system of Nature, to show evolution and relationships. Dull indeed is the imagination which cannot foresee the intense interest which would attach to certain groups, such for example as the *Cervidae,* when it is possible for the eye to comprehend in one sweep the long line of forms related to the Altai Wapiti. Imagine, also, the radiation of the genus *Ovis* from western Mongolia southward to India, westward to Sardinia and Morocco, and northeastward by the grand loop to Kamchatka, Alaska and Mexico.

"The second series naturally would be created to display the ungulate resources of the continents; and herein would maps of the geographical distribution of families, of genera, and of species be strongly in evidence. In this series would be shown the centers of distribution and the culminating points of many species popular with American sportsmen and naturalists."

That was the plan. Possibly better than any others in the country, because they combined the enthusiasm of the sportsman with the knowledge and keen curiosity of the scientist, Mr. Grant and Dr. Hornaday realized the swiftness of the decline in the abundance and superior racial characteristics of the wild life of the world, and they knew only too well the immediate necessity of preserving noble memorials of it while there was yet time. It would have been better to have started fifty, a hundred years, earlier, before some species, such as Père David's deer, became well-nigh extinct, and before improved means of transportation and improved firearms began to take their inevitable toll of the finest breeding specimens of all kinds, but there still was time to act.

What they were undertaking, of course, was nothing less than a complete and worthy memorial to the vanishing big game of the world, and to establish it, to give the dream reality, Dr. Hornaday presented his personal collection of heads and horns to the Society.

It was a nucleus that defined many of the lines the completed collection would develop and fill out. In all there were 108 species represented by 131 specimens—9 species and 21 specimens of bison and buffaloes and their relatives; 12 species and 19 specimens of mountain sheep; 8 species and 8 specimens of goats and ibexes; 44 species and 44 specimens of antelopes; 32 species and 36 specimens of caribou, moose and deer, and 3 species and the same number of specimens of tusked animals.

The gathering of that collection had been the work of comparatively few years. As a hunter-collector for Ward's natural history establishment, Dr. Hornaday had collected many fine trophies in all parts of the world, but none of them had he kept for himself. It was only after he became Director of the new Zoological Park that he began to acquire a few fine heads and horns, performing what he had urged other sportsmen to do.

In those days it was the custom of Carl Hagenbeck, the great German animal dealer, to make presents of heads and horns to his friends and to the Directors of zoological parks with whom he had business dealings. Hagenbeck's men in the field were instructed to ship back to Germany any fine trophies they encountered and every year, or when some especially important order was placed with the firm, a fine pair of horns would be sent along with the animals as a surprise gift to the purchaser.

"Hagenbeck gave me some fine horns," Dr. Hornaday once recalled. "The finest, perhaps, was a colossal pair of horns of the Siberian argali, *Ovis ammon.* That pair came along as a present from Hagenbeck on some occasion that I have forgotten. His men obtained it in the Altai Mountains, the home and center of distribution of the largest of the world's mountain sheep. When it arrived, the skin was dried down on the skull and so the entire skull was perfectly preserved."

In describing the horns in that first Heads and Horns Brochure, Dr. Hornaday remarked that "The fully adult male argali stands about 48 inches in shoulder height, but for its body to be in fair proportion to its enormous horns, it should be five feet high. An extra large pair of horns of this species is the grandest trophy a sheep-hunter ever can secure, not even excepting the wide-horned *Ovis poli* of Tibet."

At that time, 1907, Dr. Hornaday's specimen stood Number 4 in Rowland Ward's "Records of Big Game." In the latest edition of that valuable but far from complete record (especially incomplete insofar as records of trophies in the United States are concerned), the specimen in the National Collection heads the list under the special classification of "Owner's Measurements," indicating that it has not been officially measured by Ward. Its measurements are given as 59⅛ inches in length on the front curve; 19½ inches in circumference; and 40 inches from tip to tip.

Today the world's record head of *Ovis ammon,* according to Ward's "Records," is in the possession of St. George Littledale and its corresponding measurements are 62¼ inches, 19¾ inches and 38½ inches.

Whether by gift or by purchase, Dr. Hornaday had made his collection always with the purpose in mind of showing important species. Among the antelopes, in particular, he had made his selection of 35 species with care to illustrate the different genera and after that the most noteworthy and characteristic species.

In forming his collection of deer antlers, he had purposely sought the rarer and lesser-known foreign species and especially those of Asia instead of the comparatively plentiful North American species. It was well that he did so, for he was early in the field and was able to obtain some specimens that it has since become almost impossible to find.

"Of all deer antlers, the rarest and most eagerly sought by those who collect on zoological lines are those of the well-nigh extinct Père David's deer, formerly of China but now of zoological gardens only. There are today (1907) precisely twenty-eight living specimens between *Elaphurus davidianus* and total extinction," he wrote.

Formerly there had been a herd of about two hundred Père David's deer in the Imperial Park south of Pekin, but it was entirely destroyed during the Boxer war, so that in China, the native haunt of the animal, not one specimen was living then, nor is there one today, so far as is known.

The species is still kept alive by a small herd of about thirty head maintained in Woburn Park in England by the Duke of Bedford. In Ward's "Records" only eighteen pairs of antlers are recorded, of which the Smithsonian Institution has the largest, and the Duke of Bedford five pairs. Dr. Hornaday had acquired two pairs, one of shed antlers and one with the antlers attached to the skull, and both pairs were included in the Nucleus Collection.

It is hard to estimate the monetary value of such things for which there is no established market price, but in 1907 Dr. Hornaday made an exchange of one pair of Père David's deer antlers on a basis of $400.

UP to the time that the National Collection was actually formed, Dr. Hornaday kept his collection in his home in nearby Bedford Park and in his office in the Zoological Park, in a wing of what is now the service building. As a necessary dramatization of the formation of the National Collection, he moved all his heads and horns to the Park. All that he reserved, all that remained to remind him of his years as a sportsman and collector, was his own little private trophy collection: the head of a bison he had shot in 1886, a fine mule deer head from Hell Creek, a mountain goat head from British Columbia, and a pinacate mountain sheep head from Mexico. That little nucleus never grew, however; he has those heads today, and they

A present from Hagenbeck, the animal dealer: the magnificent skull and horns of the Siberian argali given to Dr. Hornaday and presented by him to the National Collection.

are all he has. Everything else went into the National Collection.

There was no more room for his collection in his office, and in any event he wanted the whole collection to be together as nearly as possible. Temporarily it was housed in a storage room in the Lion House and in a similar space in the Bird House. At that time, plans were being drawn for the Administration Building and work was to start on it in the fall of 1908, with the dedication scheduled for the following year, but actually it was two years before the building was completed. Pending the carrying out of the original plan for a separate building specifically designed to display the National Collection, Dr. Hornaday's gift and any additions to it were to be exhibited in the two picture galleries in the Administration Building.

Long before the latter building was completed, the founders began to see their dream taking concrete form. Eventually, of course, a substantial accomplishment of their desires was inevitable, for Mr. Grant and Dr. Hornaday had placed the situation before the sportsmen of America in terms that could not fail to interest them. They had warned them that America was late in starting and in foreign species was already far behind the South Kensington Museum, into which British sportsmen for generations had poured their finest trophies; they appealed to American sportsmen on the grounds of scientific interest and national pride. Such an appeal could not fail in bearing fruit—and important fruit it was.

"The record of the first year is profoundly gratifying," Dr. Hornaday wrote. "It shows, beyond the possibility of doubt, that the idea meets the hearty approval of American sportsmen, and that they will work it out to a splendid consummation."

Gifts came from British Columbia and China, California and London and Philadelphia, and New York contributed what was by far the most outstanding accession of the first year, the great Reed-McMillin collection of heads, horns and skins of Alaskan big game.

A. S. REED was an Englishman who between 1896 and 1902 lived at Victoria, British Columbia. In those days Alaskan big game was plentiful and big—much more so, certainly, than it was even in 1908, or has been since.

"The hunters of even less than ten years ago," Dr. Hornaday wrote in 1908, "were able to take their pick of the huge individuals who had fed fat and grown colossal in size, without the dangers and casualties of today. In 1900, heads were obtainable by persistent sportsmen which are now very hard to secure in the wilds. The period of real moose and caribou slaughter set in about 1900, and since that date very few sportsmen have collected moose-heads of 70 inches or above."

Mr. Reed was an indefatigable, if selective, hunter. On his frequent hunting expeditions to Alaska and northern British Columbia, he made it a practice to hunt very late in the fall or early in the winter, and to go after bears at the earliest possible moment in the spring. He shot only the best and most magnificently representative specimens, and the choicest heads and skins he carried back to Victoria for mounting by Fred Foster, the outstanding taxidermist of the Pacific coast. The result was, of course, an unparalleled collection of Alaskan big game.

For some years it was displayed on the walls of the Union Club in Victoria, but when Mr. Reed returned to England for permanent residence in 1905 the problem of disposing of the collection became acute. At first it was offered for sale at $10,000; then the price was reduced to $6,000. Both Dr. Hornaday and Mr. Grant knew what remarkable trophies it contained and were anxious to obtain it for the young National Collection. While they were in process of organizing a popular subscription to buy it, they got in touch with Mr. Reed and offered him $5,000 for the heads and horns, leaving out a large group of valuable bear skins.

The reply was typical of the sportsman that Reed was; he replied that he did not like to divide the collection in any way, and that he would be willing to sell it to the National Collection—all of it, as it stood—for the $5,000 offered for a part.

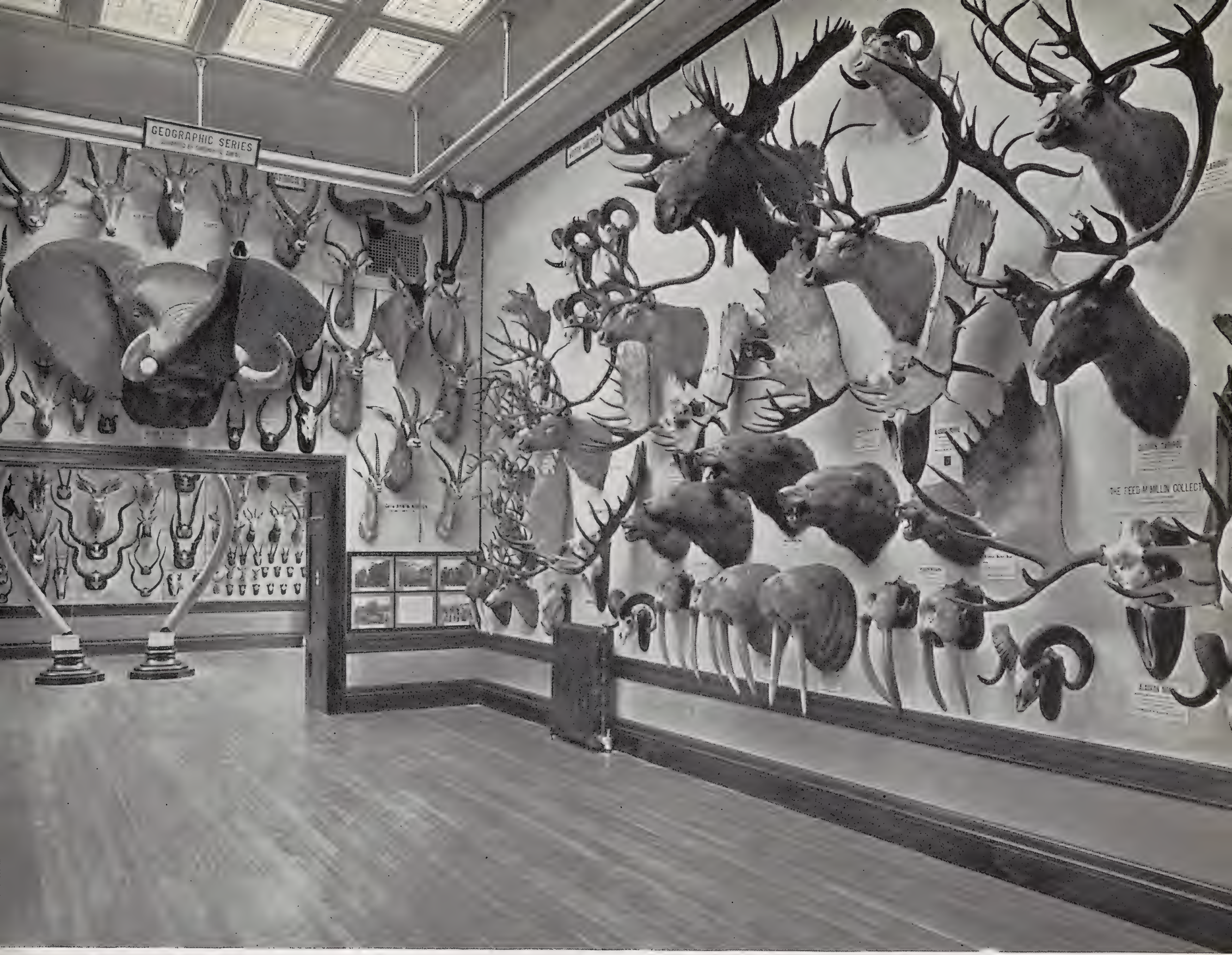
"At this juncture," Dr. Hornaday commented, "Mr. Emerson McMillin of New York—banker, art connoisseur, big-game hunter and member of the Camp-Fire Club of America—intimated to me his desire to do something for the National Collection. When the proposal regarding the purchase of the 'Reed Collection' was fully placed before him, without an instant's hesitation he said, 'You buy the collection, have it brought on to New York, and I will pay both cost and carriage.' "

On October 16, 1907, truck loads of big packing cases arrived at the doors of the Lion House. The National Collection was beginning to grow and to fill out.

The founders had not failed to make it clear that completeness was their aim; that the National Collection eventually should possess *two equally complete* sets of heads of every species of hoofed animals. The attainment of such an ideal necessitated gifts from many sources, and gifts were not slow in coming.

Mr. Grant presented the collection with an extraordinarily large pair of walrus tusks and a family of white mountain sheep heads, a male, a female and a young specimen, from the "farthest North" of their species, the extreme northern end of the Rocky Mountain chain, within fifty miles of the Arctic Ocean, and later gave two Rocky Mountain bighorns and a Columbia mountain goat.

To help fill out the African groups, John Roger Bradley sent heads of a Coke hartebeest, an impala antelope and the common waterbuck, and contributed also a fine head of a Siberian argali and the mounted head of an Atlantic walrus. George L. Harrison, Jr., of Philadelphia, sent three shipments of African heads, representing about sixty species. The African groups were further enriched by an extensive gift from John W. Norton of New York and



This is how the National Collection was displayed in the days when it was hung in what is now the art gallery in the Administration Building. Many of the heads at the right are in the Reed-McMillin Collection.

Cazenovia, including a greater kudu, an eland, a Baker roan antelope and a Crawshay waterbuck. Besides those heads, he presented the collection with three from Wyoming, one of which was the head of a female prong-horn antelope that bore horns.

Caspar Whitney gave the museum a finely-mounted head of a wood bison, from an animal apparently about six or seven years old. Warburton Pike, probably the first sportsman who penetrated the Barren Grounds north of Great Slave Lake and saw the musk-ox at home, offered a tremendous musk-ox head that stood high among the record heads. From George H. Gould of Santa Barbara, California, came a mountain sheep head that Dr. Hornaday described as "not only one of the finest heads ever taken on the American continent, but . . . probably the greatest trophy of *Ovis canadensis* that ever fell to the rifle of a gentleman sportsman."

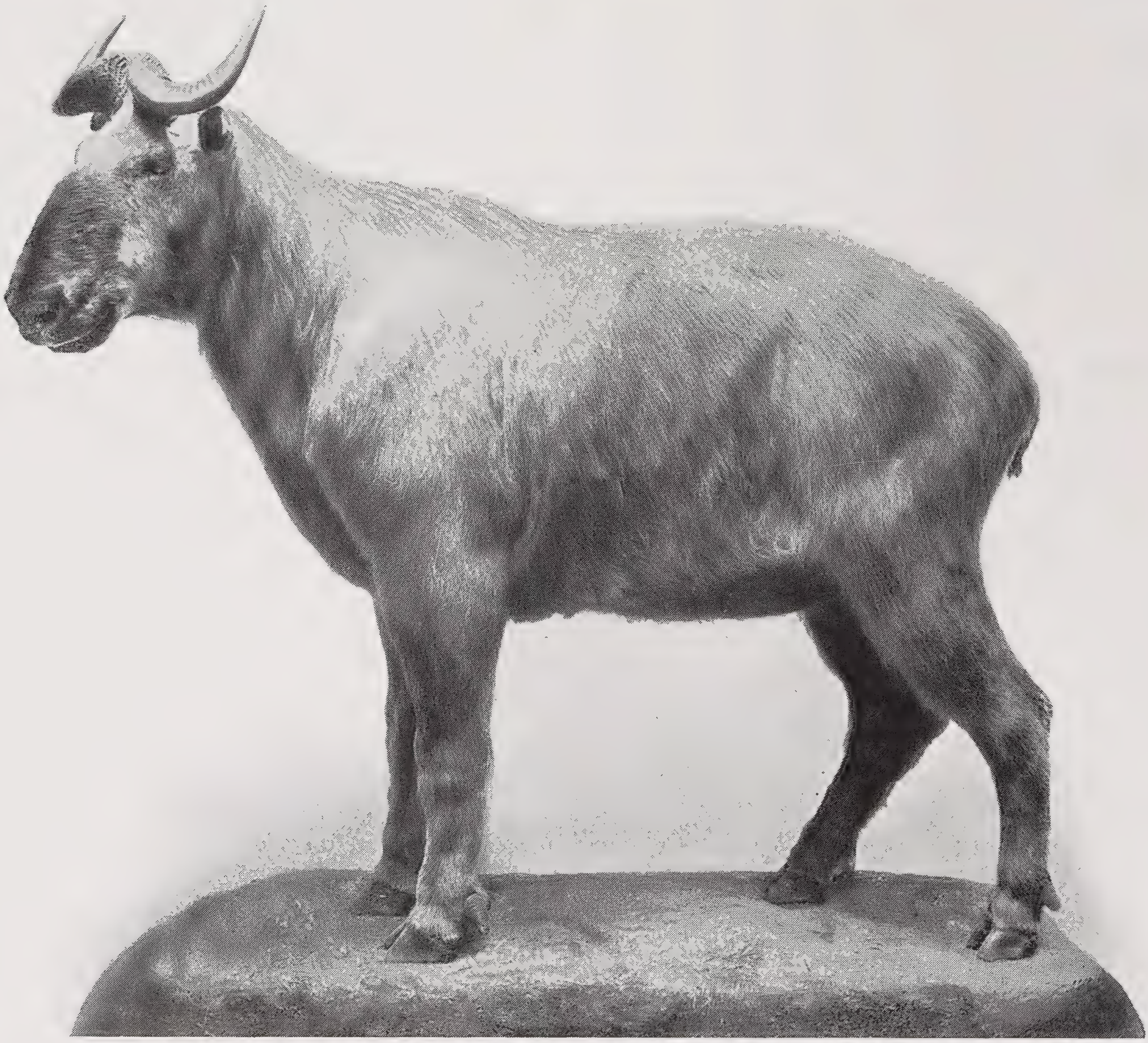
Even China contributed in that first year. Mason Mitchell, the American Consul at Chungking, forwarded what was the rarest specimen in the young collection: the entire skin, skull and horns of a takin, from Szechuan, Western China. That form had only recently been discovered and it was named *Budorcas taxicolor mitchelli* in honor of its discoverer. Mr. Mitchell himself had shot the specimen and it arrived safely and in good condition after five months' transit, swathed in many layers of cloths impregnated by "the most pungent of the powders that are dealt in by the Chinese apothecary to keep off bugs, mice and rats of all sorts."

Out of a special interest in the wapiti group, Ferdinand Kaegebehn presented a fine pair of antlers of the Arizona wapiti from the Santa Catalina Mountains, of which only three pairs were known to be in existence. The animal itself appeared to have become extinct about 1901. It is probable that those antlers filled a place in the collection that could not have been filled otherwise.

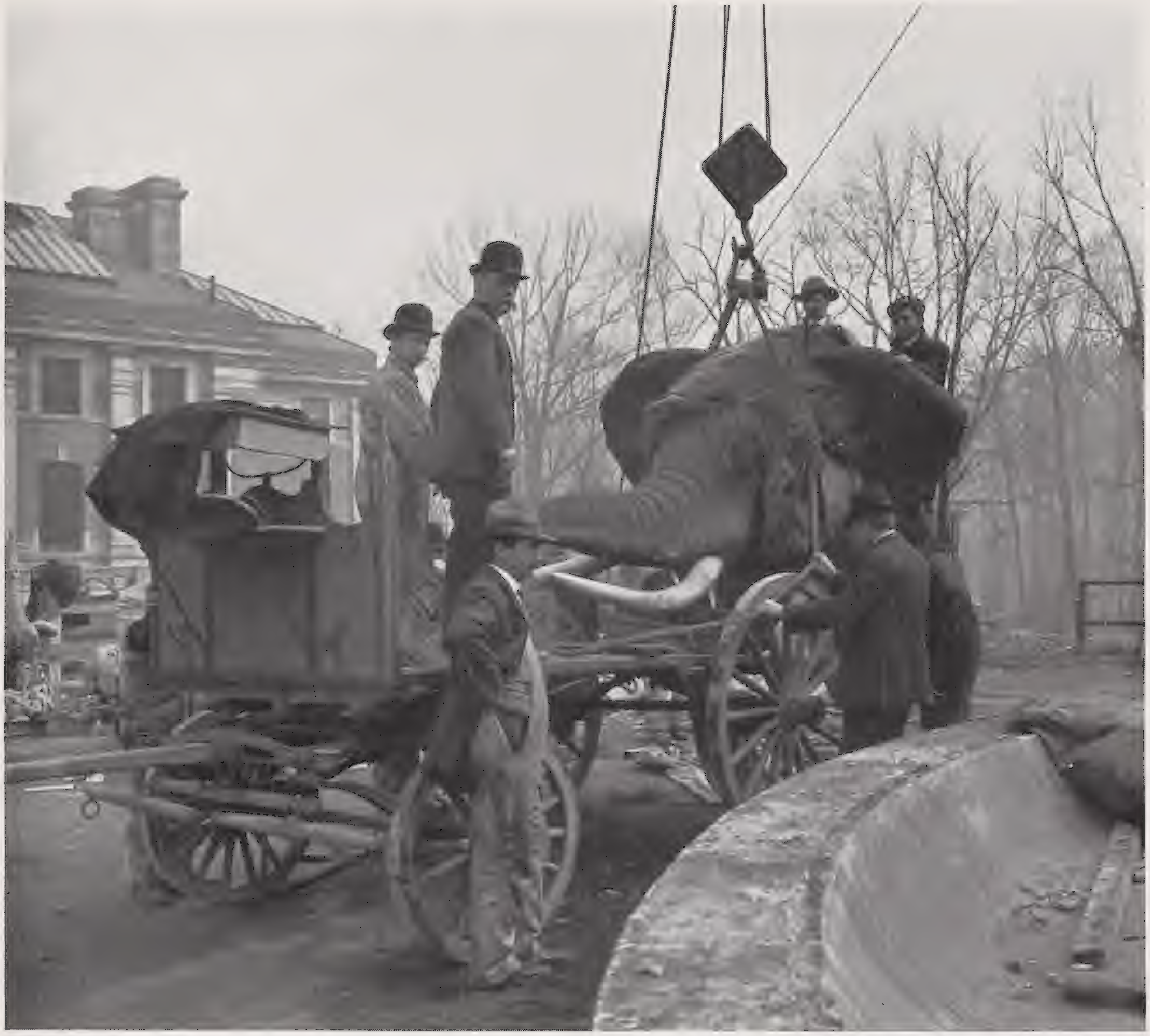
From a dozen other donors that first year came interesting and desirable gifts. All the available space in the Lion House was filled to overflowing and it was a relief to everyone when the Administration Building was finally opened for occupancy on November 15, 1910. Then the trophies were taken down from the burlap-covered walls of the Lion House and properly hung in the two picture galleries that were their home for the next twelve years.

The Administration Building was put into use before it was really ready for full occupancy and for many months after the National Collection was hung there the galleries could not be opened to the public, although men who were especially interested were taken upstairs to see it.

Simultaneously a campaign was under way to house the collection permanently in a building of its own and to obtain funds that could be used to purchase particularly desirable heads that came on the market. In that work, Mr. Grant was indefatigable. He watched over the growing collection as sharply as Dr. Hornaday and when opportunities arose to fill important lacunæ he gave the needed heads. His gifts were not in the form of a large, single collection, but rather a wide range of North American desiderata. A fund of $100,000 was in process of being raised for building and purchases and he was instrumental in obtaining much of it. Before the Heads and Horns Museum was actually opened in 1922 it appeared



A real rarity from China was the takin, sent to the young National Collection by Mason Mitchell, the American Consul at Chungking, who shot the animal and for whom the form was named.



Some of the specimens presented engineering problems—such as the great Tjader head of an African elephant lent to the National Collection in 1910 by Mr. Samuel Thorne and still on exhibition in the Zoological Hall.

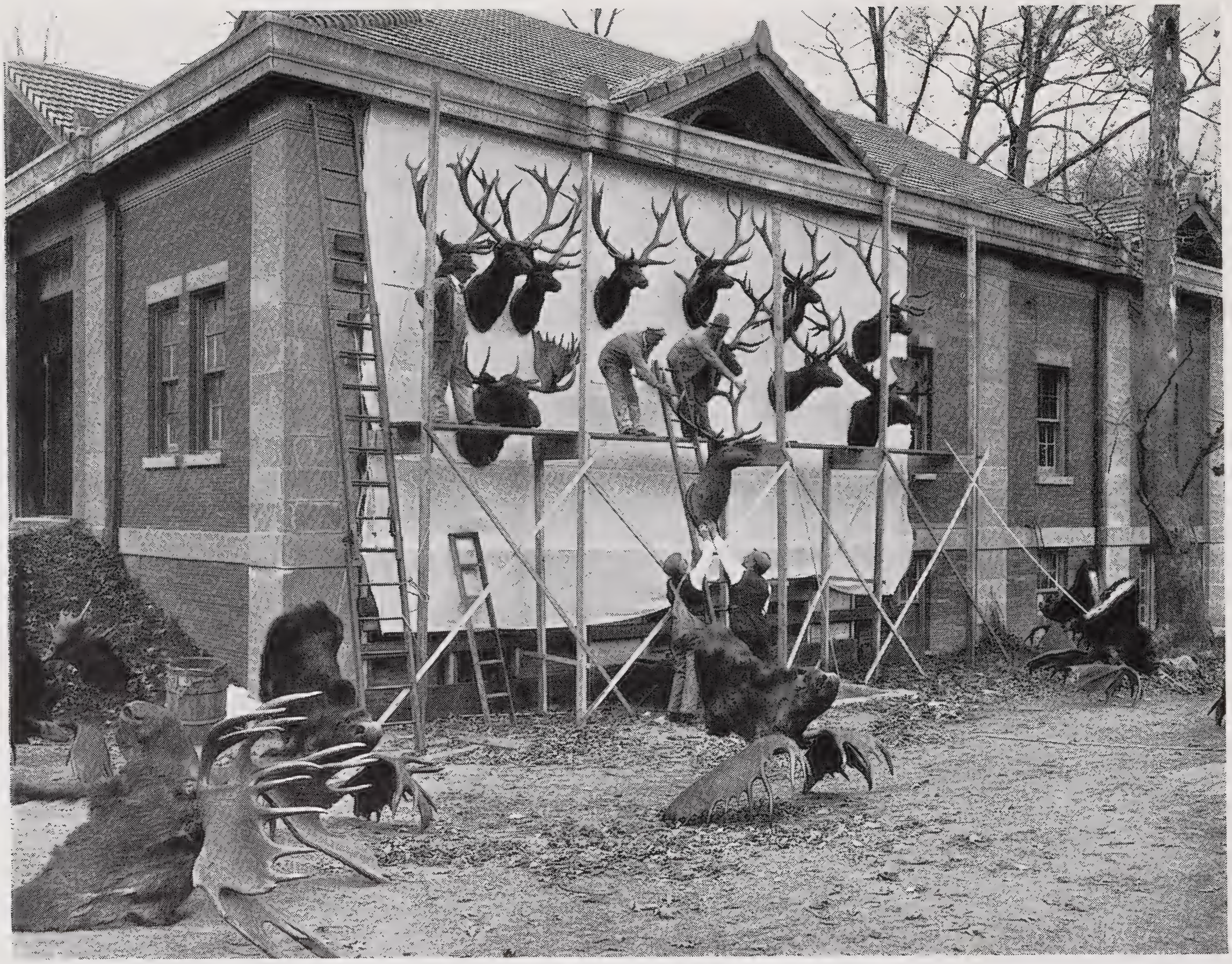
that $10,000 would be necessary to fill gaps in the collection, and Mr. Grant undertook, successfully, to raise the money and thus virtually completed the main branches of the geographical and zoological series before it moved into its permanent home.

By 1915 it seemed probable that the new Heads and Horns Museum building could be financed and erected without delay, but it was wartime and prices of building materials were skyrocketing. The available funds proved insufficient and building had to be postponed until 1921. On May 25 of 1922 the Museum was opened, at a cost of $140,000.

"With the dedication and opening on May 25 of the Museum of the National Collection of Heads and Horns, another dream comes true," Dr. Hornaday wrote in the BULLETIN that signalized the event. "It is complete in almost every detail, and it far surpasses the original hopes of its founders."

With what satisfaction he wrote those words only he and Mr. Grant can realize. It is not often in this life that one can say of anything: "Another dream comes true," and to add, for good measure, that the realization exceeds the original hopes.

One thing he failed to write about—the tre-



Finding space to display and photograph the rapidly growing National Collection in the early days was always difficult, and the Park met the difficulty in the case of the Clarence H. Mackay Collection of Alaskan moose, elk and bison by hanging the heads on a temporary wall on the side of a building.

mendous labor involved in housing the collection. Labels had to be made and proofread, identifications had to be checked and rechecked, every item had to be properly placed.

"I had the measurements of the wall space marked out on the floor and with the help of George A. McCluskey and John Rose, two of the Park's carpenters, I placed each specimen on the floor in the position it was to occupy on the wall, and then they hung the specimens," said Dr. Hornaday. "Before it was over, and the building opened, I nearly went crazy."

As it stands today, the National Collection is complete in one way—and in another, it is still incomplete. There are no important gaps in the two series of exhibits; every major species of the horned and hoofed animals of the world is represented in both lines. Sub-species are lacking in some instances, and so they must always be. There are, for instance, almost innumerable subspecies of the African black, or Cape, buffalo, each one differing from the others by extremely minor points and possibly largely classified as subspecies because of their range. It would be unnecessary as well as confusing to exhibit specimens of every subspecies, but the National Collection contains five specimens that stand very well for the whole species, ranging from the massive Cape buffalo itself to the small Congo buffalo at the northern end of the range.

Where the National Collection is still lacking is in the perfection of its exhibits. From the very beginning heads that were definitely "poor" were excluded, but perforce some had to be admitted that could only be classified as mediocre, if anything approaching completeness was to be attained. In the course of the years, many of the mediocre heads have been replaced by better ones, and even some of the "good" heads have given way to outstandingly fine examples. To realize to the fullest the dream of the founders, the collection will be complete only when every big-game species is represented and every head on its walls is the finest obtainable. Ideally the National Collection should contain nothing but heads worthy to appear in Ward's "Records of Big Game" or in the late Prentiss N. Gray's "Records of North American Big Game," the two works that stand in the same relation to the big game trophies of the world as Burke's "Peerage" does to the human nobility of the world.

From its inception to March 1, 1935, the National Collection has acquired by gift or purchase 2,098 specimens. It still needs a few species. In some cases better heads are desired to replace low records already on the walls and in others mounted heads are needed to replace mere horns.

In 1928 the Heads and Horns Committee of the Zoological Society drew up a list of desiderata and that list, supplemented by the suggestions of Curator M. S. Garretson, follows, all the items desired being fine mounted heads:

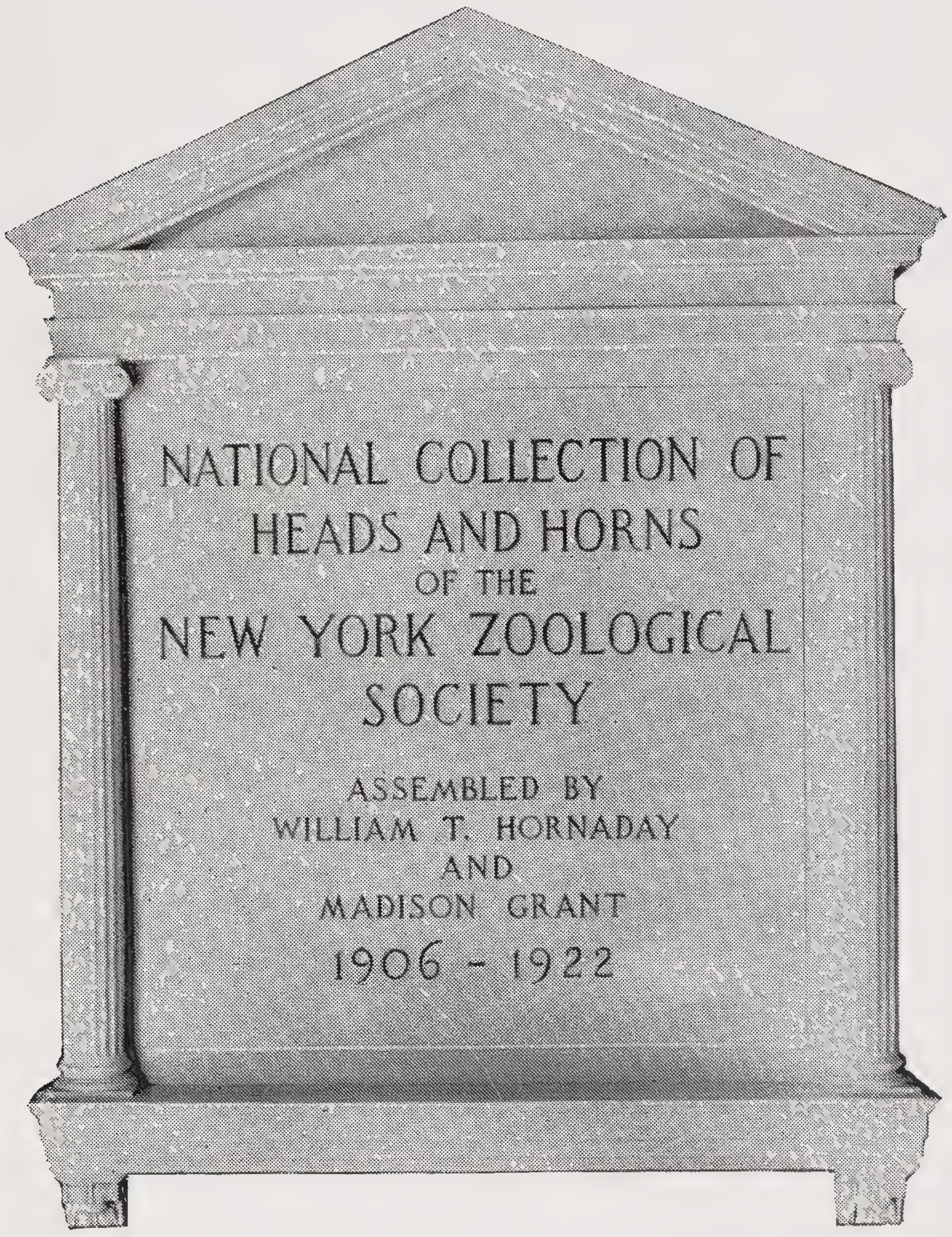
ZOOLOGICAL SERIES

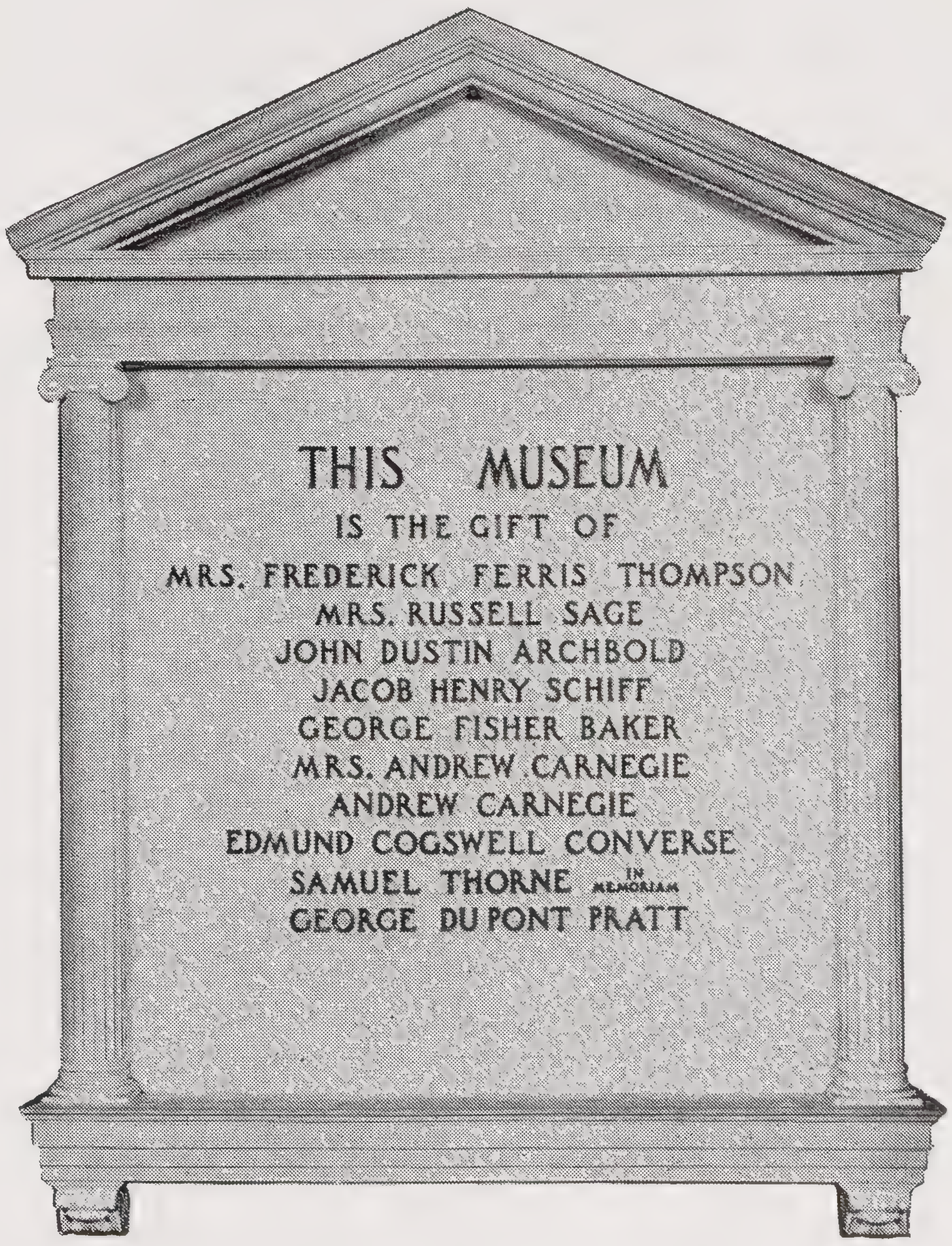
Sumatran rhinoceros
Abyssinian wild ass
Père David's deer
Indian elephant
(with large tusks)
Pygmy hippopotamus
Pygmy African elephant
Giant forest hog
Red River hog
Chitral markhor
Chiru (Tibetan antelope)
Derby eland
Schomburgk's deer
Bornean banting
Saiga antelope
Mountain nyala

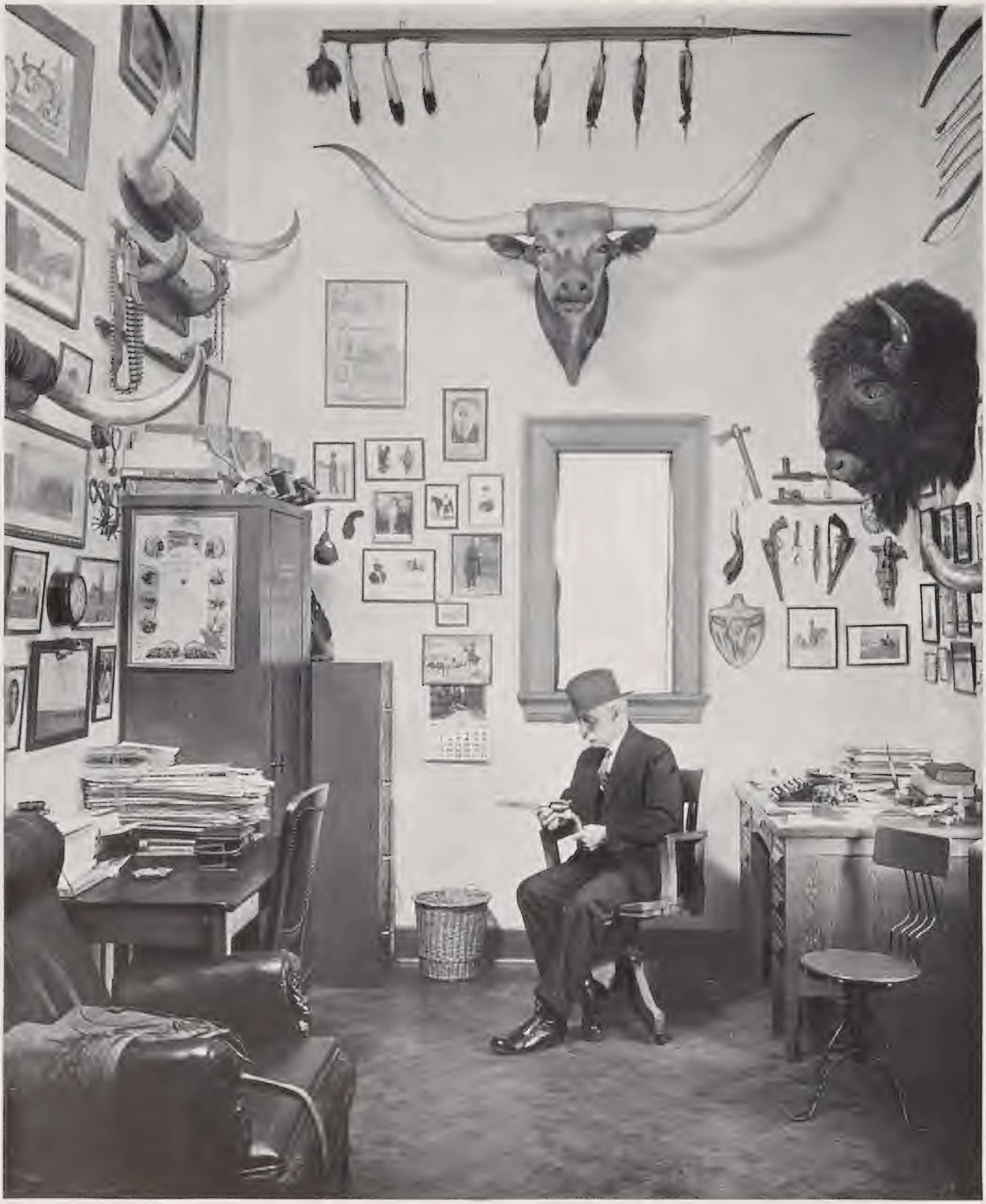
GEOGRAPHICAL SERIES

Dwarf African buffalo
(male)
Persian wild ass
Onager
Chillingham bull
Chitral markhor
Chiru (Tibetan antelope)
Bornean banting
European moose
Okapi

Even if all those heads should be miraculously added to the collection, would it be complete, finished, definitive? Probably not. There will always be a finer head, somewhere, that sportsmen will envy for the National Collection.







M. S. Garretson, the Curator of the National Collection of Heads and Horns since 1924, has his own private collection of trophies in his office in the Museum. He knew the West in its wilder and woolier days and his trophies reflect a day when it was still a hunter's paradise and when cattle men carried guns—and used them.

Trophies of the Chase

A Survey of the Present Exhibits in the National Collection of Heads and Horns

CLAUDE W. LEISTER
Curator of Educational Activities

As a rule, every collection of worth-while objects has some outstanding specimen which serves as a nucleus of attraction and during the course of time contributes largely to the reputation of the collection.

In such a light we should judge the African elephant tusks, the gift of Mr. Charles T. Barney, which have been a feature of the National Collection of Heads and Horns for years. Since they have been on exhibition they have probably evoked more questions from visitors than any other specimen. For this there is good reason, because they are of almost incredible length and bulk. To the average person it seems well-nigh impossible that they were once carried by a living elephant. Beyond the consideration of mere size, their chief features are their graceful curve and symmetry, for they are practically identical. The right tusk is 11 feet, 5½ inches long and the left tusk 11 feet long. The weight of the pair is 293 pounds.

Until recently these held the world's record for a pair of tusks on public exhibition. One larger pair was known to be in existence. Each tusk was more than 12 feet long, and the combined weight was more than 400 pounds. However, only one tusk was on exhibition and the other was privately owned. Not long ago the pair was reunited in the British Museum and the pair in the National Collection was forced into second place.

The Barney tusks were apparently once the property of King Menelik of Abyssinia, and were given by him to a European official. Eventually they found their way to the London ivory market where they were "discovered" by Rowland Ward, from whom they were purchased for this collection. We have a more complete history of the British Museum pair, and Mr. Garretson, Curator of the National Collection of Heads and Horns, furnishes the following notes concerning them:

"The largest elephant tusks of which there is any record were taken from an old bull, killed with a muzzle-loader by an Arab slave at the base of Kilimanjaro in 1898. They weighed 228 and 232 pounds, a total of 460 pounds, and each measured more than 12 feet in length. They were sold in Zanzibar for £1,000—nearly $5,000—the greatest price that has ever been paid for the tusks of a single elephant.

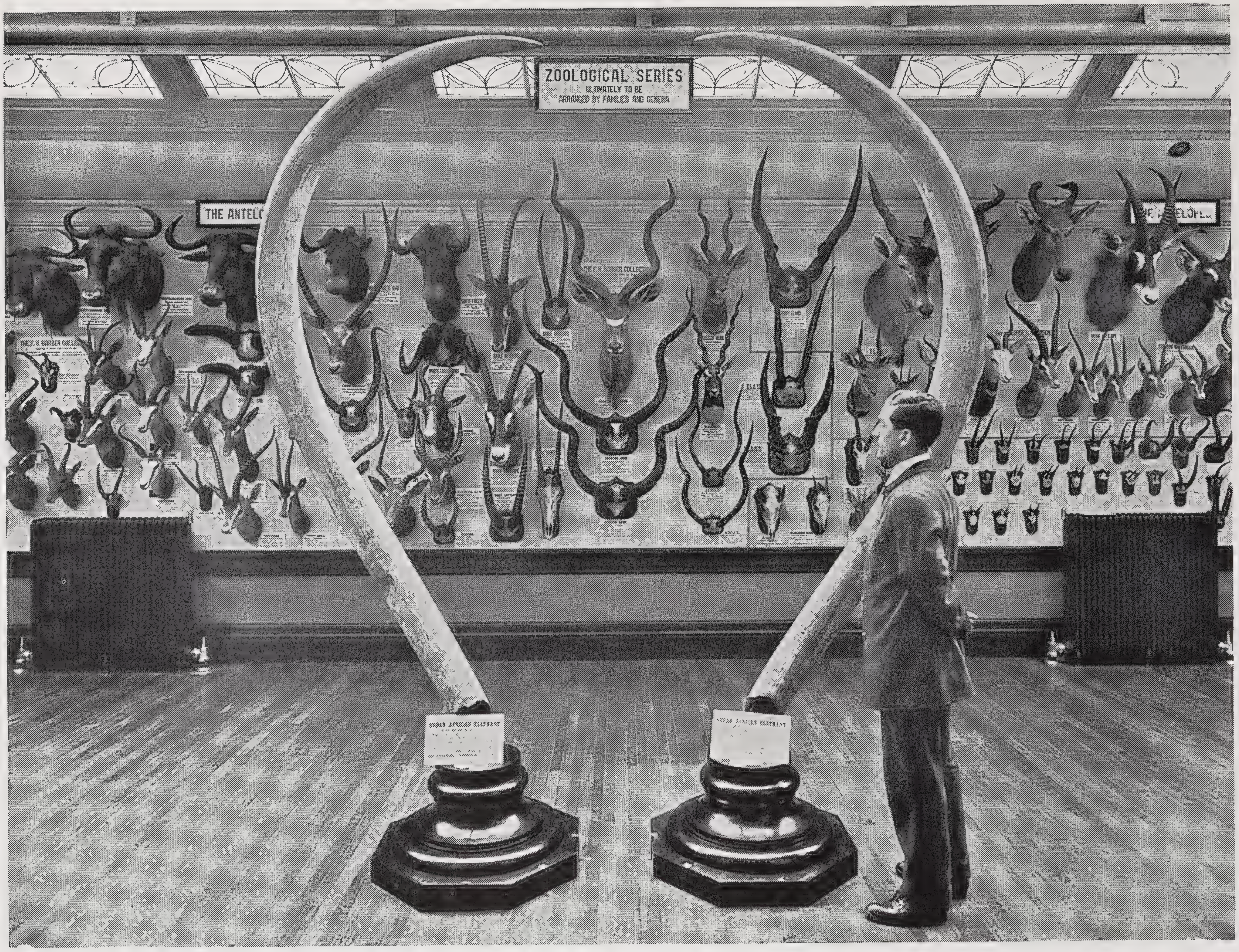
"The slave who shot the animal said that, as the animal stood, his tusks almost reached the ground. He was not a big elephant but had the high shoulders and sloped away in the back 'like a hyena,' the kind of elephant the old Arabs in Zanzibar always said carried the heaviest ivory.

"These tusks created quite a sensation not only in East Africa but also in Europe and in America where they were exhibited in Tiffany's windows in New York.

"One of the great pair was purchased for the British Museum of Natural History at South Kensington; the other was kept in the private collection of the ivory-cutters at Sheffield until 1933, when it was purchased for the Department of Zoology at the Museum. Thus the pair are now together again.

"As to whether these are the largest tusks ever secured from an elephant, we cannot be quite sure. Burton, in 1872, spoke of hearing of a pair weighing approximately 280 pounds each, that had been sent from Mozambique to the King of Portugal, and Von Hohnel tells us that his ivory-trader guide knew of a tusk which weighed 264 pounds. At any rate, the two Kilimanjaro tusks are the largest of which there is any generally accepted record."

The sight of giant tusks, such as the above, easily carries one's imagination back some 25,000 years to the great elephant of that day, the mammoth. Indeed, the average visitor to the Heads and Horns Museum is led to remark that he finds it hard to believe that any present-day elephant could bear such tremendous structures of ivory and that they must have been carried by some animal long extinct. Happily, we now have, for the purpose of comparison, a world's record mammoth tusk on display in the Geographic Hall of the Museum. It is a fine, typi-

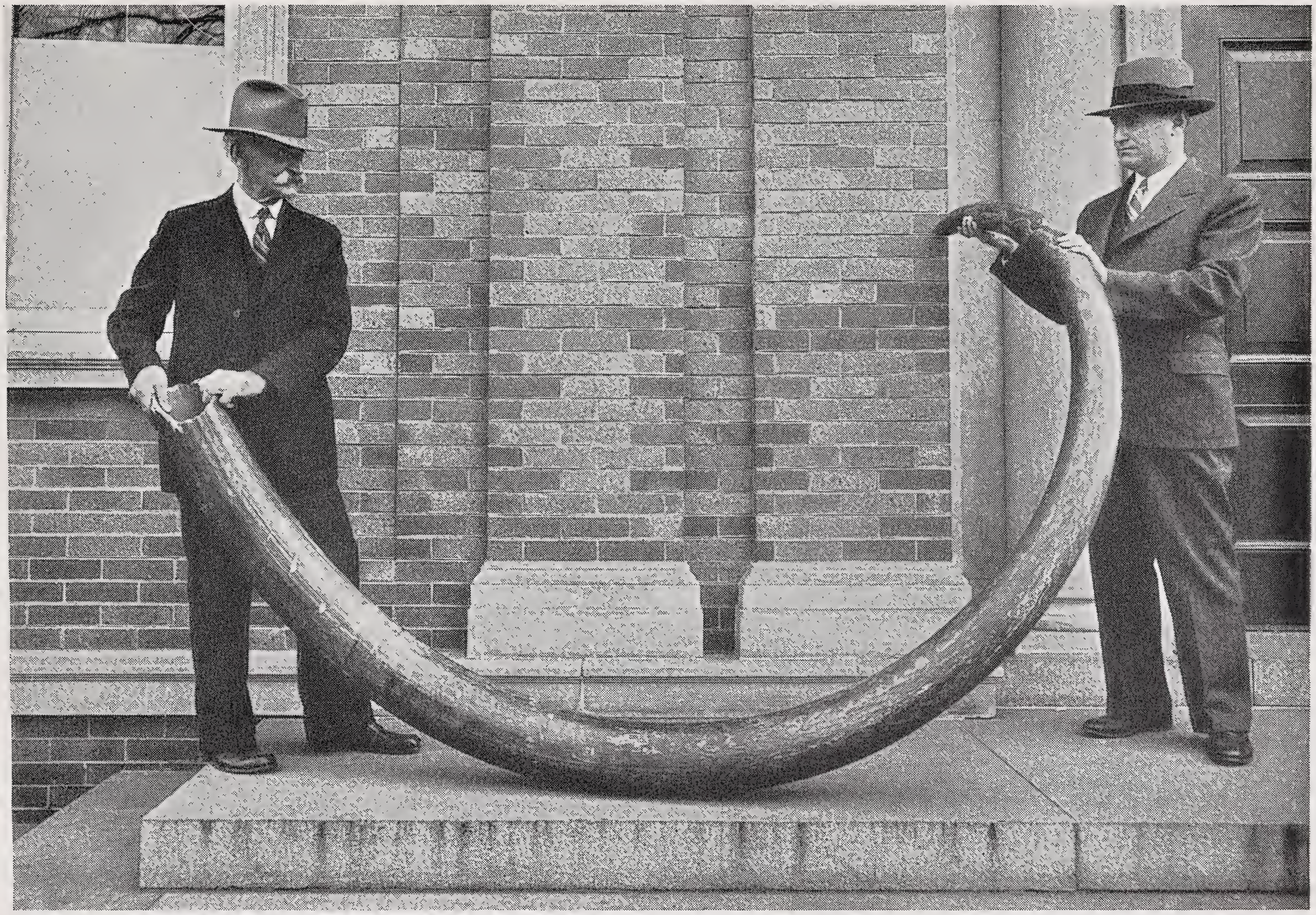


A present-day elephant carried these enormous tusks, the second largest pair in the world. This picture shows how they were displayed when the National Collection of Heads and Horns was still housed in the Administration Building.

cal example of the Siberian mammoth. Dr. Blair purchased this specimen in 1931 from the London establishment of Rowland Ward, who had received it from Russia a short time before. Although this specimen dates back to the last ice age, it is in excellent condition and remarkably well preserved. The ivory is still light in color, generally smooth and polished, and surface checking is not extensive. It is 13 feet 9 inches in length and 20$\frac{3}{16}$ inches in circumference, being somewhat longer and heavier than a specimen in the Leningrad Museum, which was formerly regarded as a record.

Several other mammoth tusks are exhibited in the National Collection, including examples from the United States and Alaska but all of them are, of course, smaller than the Siberian specimen and not as well preserved. This acquisition would tend to show that although the mammoth possessed characteristically shaped tusks there was probably little difference in their size and weight in comparison to those borne by present-day elephants.

Wild cattle furnish many of the finest trophies of the chase. Not only does this group include some of the world's most majestic animals, but their display of courage, audacity and vicious tempers leaves the successful hunter with a sense of satisfaction and the thrill of conquest that is rarely obtained to a like degree in the pursuit of other animals. It is a well-known fact that hunting members of the cattle tribe is an extremely dangerous sport because the unexpected is so likely to happen. All wild cattle are rather difficult to kill and most of them inhabit brushy country where the rough going places the sportsman at a disadvantage. From the little anoa or pigmy buffalo of the Celebes



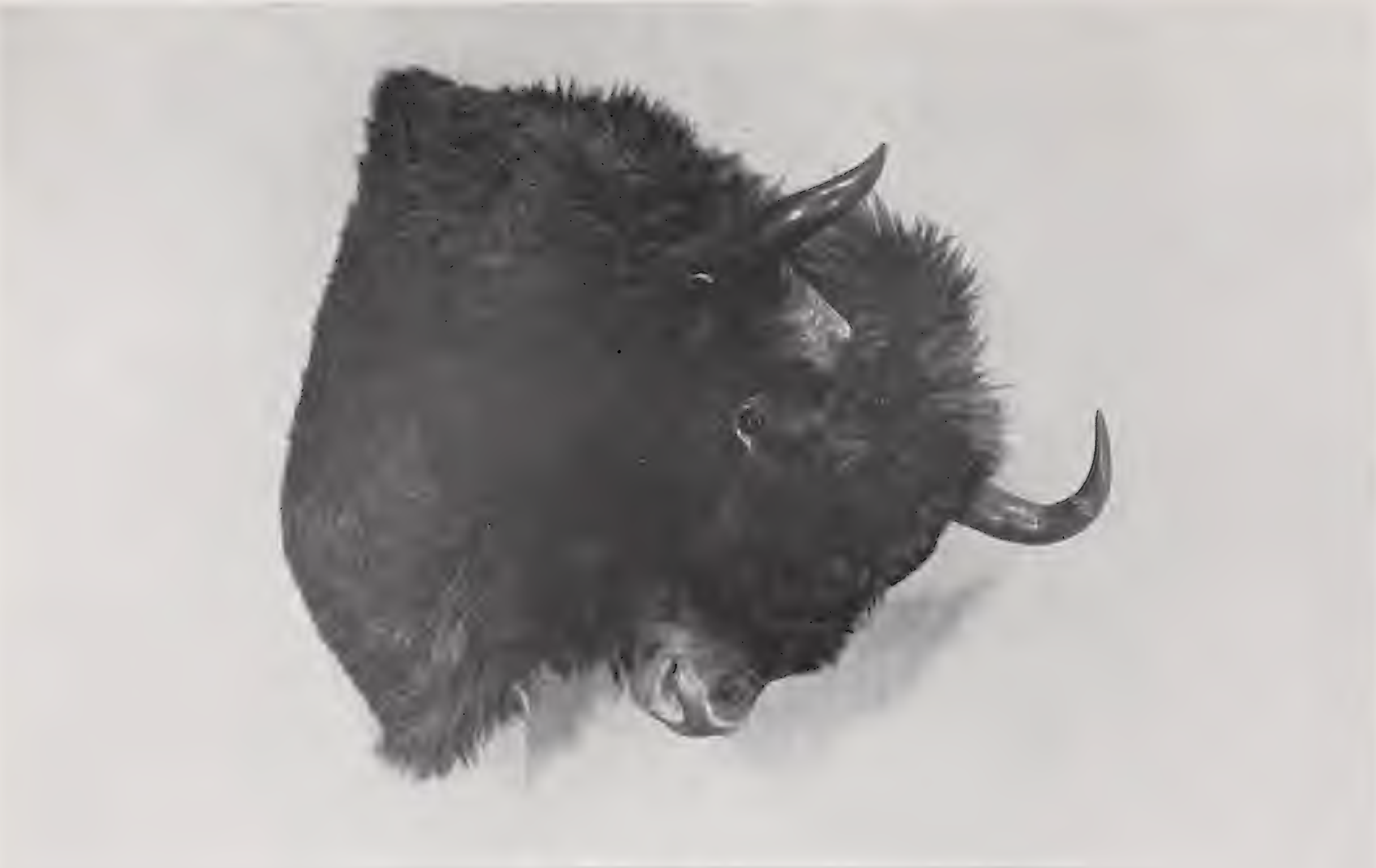
This is a world's record tusk of the Siberian mammoth, 13 *feet* 9 *inches long, but it is only* 2 *feet* 6½ *inches longer than the largest of the two elephant tusks pictured on the opposite page. It is almost perfectly preserved.*

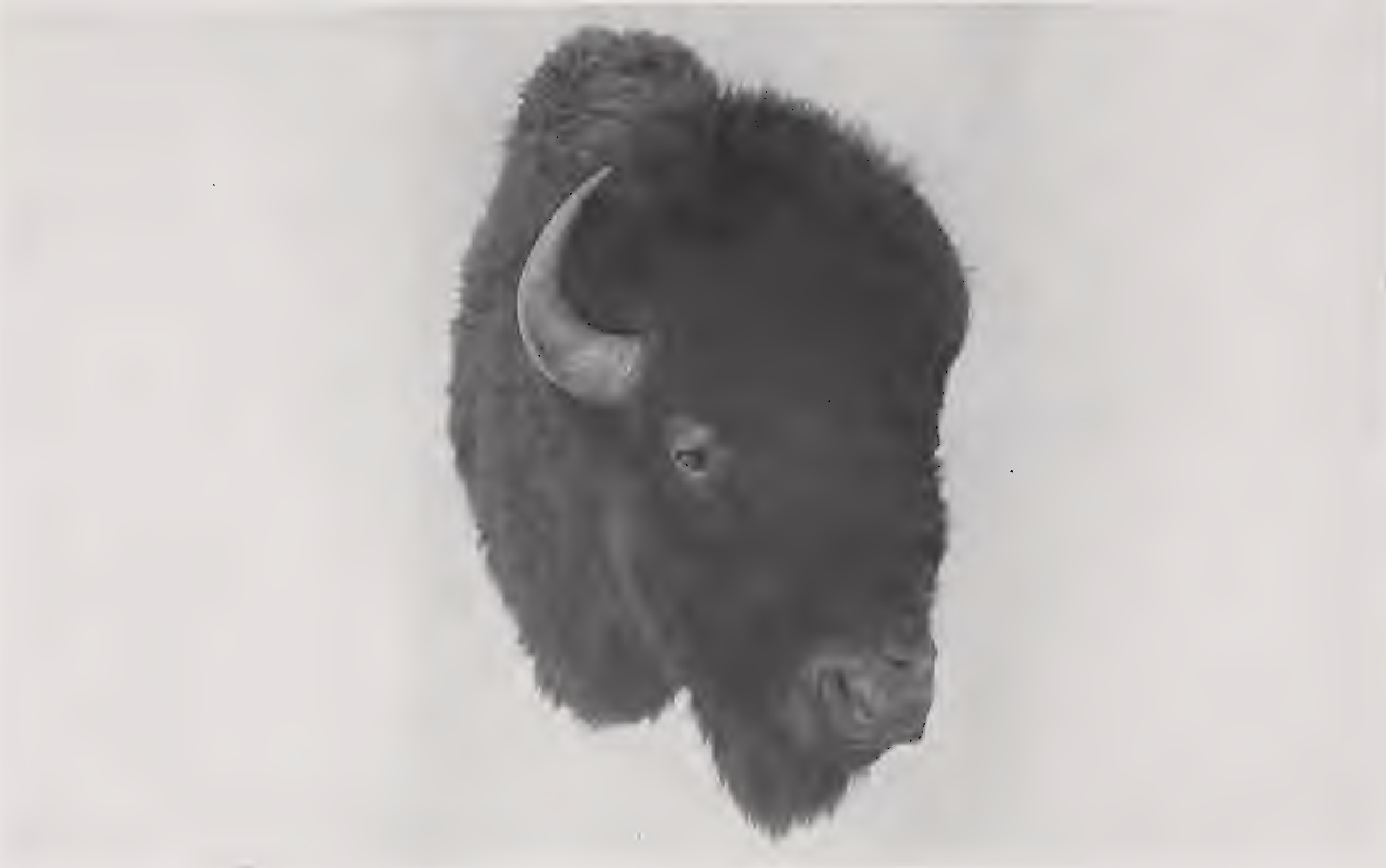
to the great Malay seladang, which frequently charges the hunter on sight, all furnish a brand of sport that is unexcelled.

The National Collection attempts to achieve completeness in exhibiting a collection of sportsmen's trophies representing all the animals that are hunted for sport. Recent acquisitions have made the wild cattle group particularly effective, and the visitor can see, almost at a glance, the principal species and races of the wild cattle of the world.

It would be fitting for this collection to exhibit the world's record head of the American bison, but while it has a number of very fine heads it can not claim the record trophy. The tragic story of the bison is now fairly well known to everyone interested in American natural history. This noble animal, in many respects the finest of the family *Bovidae,* once roamed the plains region in countless thousands. As the country was gradually opened up to civilization and especially after the completion of the Union Pacific railroad, it was slaughtered so relentlessly that by 1890 it was practically extinct. Fortunately, organizations such as the American Bison Society and the New York Zoological Society did such good work toward enlisting sentiment and help in favor of the perpetuation of this species that it was saved. The latest report of the American Bison Society stated that there are now between eighteen and nineteen thousand bison in the United States and Canada. During the period of ruthless slaughter many fine heads undoubtedly were left to bleach on the prairies. Had they been saved, they would now be the prized possessions of many a trophy hall.

Following the virtual destruction of the plains bison, the only remaining really wild herds were the wood bison, native to the Great Slave Lake region of Canada. This race is somewhat larger and darker than the typical variety. The





(Top) A representative head of the European bison, or wisent. The animal is now practically extinct and fewer than 100 *individuals are known to be still alive. This head, while not a record, is a typical one.*

(Bottom) This head of the American bison, or buffalo, shows the simple, crescentic curve of the horn, which is quite different from that of the wisent. The latter's horns are curved more like those of domestic cattle.

A recent accession by the National Collection is the Congo, or dwarf buffalo, from the forested region of central equatorial Africa.

National Collection is fortunate in possessing several examples of these northern animals which were secured some years ago, for in recent years the Canadian government has shipped surplus plains bison from its Wainwright herd into wood bison territory, a procedure which is quite likely to destroy the racial characteristics of the latter animal.

At the present time the European bison or wisent is on the verge of extinction. The International Society for the Preservation of the Wisent is striving to secure for this animal what has already been obtained for our American bison—safety from almost certain destruction. Because of the few animals left since the European War (less than a hundred), the antagonistic feelings that persist between the various countries concerned and the resulting lack of cooperation, the task is especially difficult.

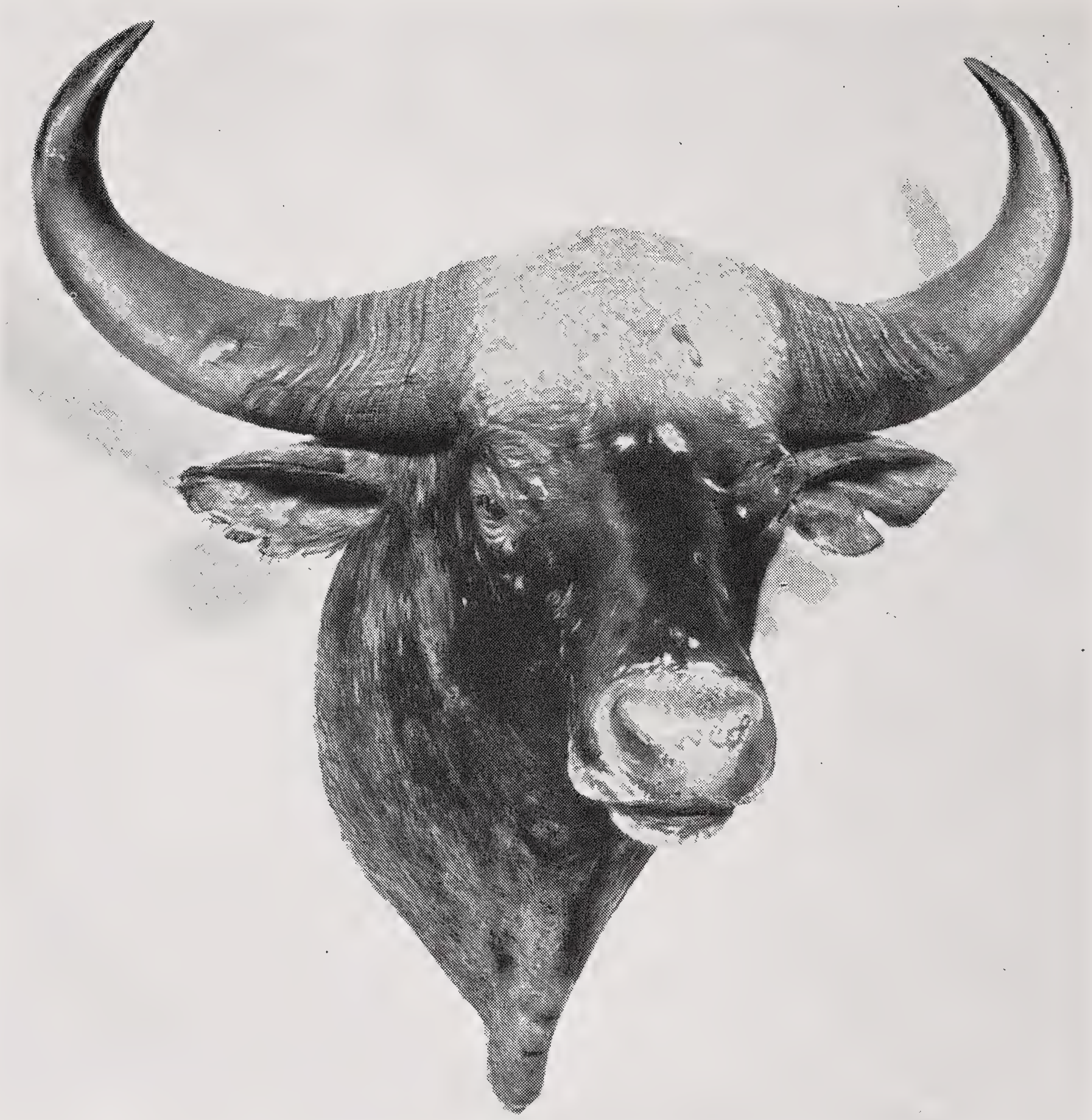
The wisent stands higher at the hind quarters than the American bison, the hair on the forequarters is not so long and the tail is longer. It is a somewhat larger and heavier animal. The several specimens of the wisent on display in this collection, while not records, are fine, typical examples of the pure-blooded species.

The African buffalo has furnished the most highly prized trophy in many a sportsman's collection. There is considerable variation in the size, shape and general conformation of the magnificent horns borne by this animal, no two being alike in all respects. It is generally agreed that there are two species, the great black buffalo, including many races, and the little red Congo or dwarf buffalo.

The Cape buffalo, about five feet high at the shoulder and jet black in color, is the largest of the African buffaloes. The Congo buffalo, about forty-two inches high at the shoulder and distinctly reddish in color, is the smallest. The many intermediate races between these two species are progressively smaller in size and tend to become red in color as they approach equatorial Africa.

The recent acquisition of a dwarf buffalo,

One of the finest big game trophies is the Cape buffalo, the largest race of the African buffaloes. This head is exceptionally large and for a long time was a world's record.



The Malay seladang is dangerous game, for he delights in "hunting the hunter" and he will lurk in ambush for a favorable opportunity to charge. He is the largest and fiercest of the cattle tribe and this fine head bears the scars of many battles.

the gift of Mr. Irving P. Taylor, filled a gap in the buffalo collection and ended a search that had endured for some years. The two species and the principal races of African buffaloes are now represented.

If an account of the hunting incidents which occurred during the course of obtaining the specimens now in the halls of the National Collection could be preserved, some most interesting reading would result. Note the following quotation from the former owner of one of the finest trophies: "This magnificent buffalo head, for a long time the record, was shot by my cousin. The scar on the left horn was caused by the bullet from an elephant rifle when charging within five yards. This caused the buffalo to swerve, and saved my cousin's life. However, it gored and killed his splendid shooting horse."

In the search for record examples of the more strikingly handsome animals generally preserved as trophies, the smaller species have not been lost sight of, and so we find one of the smallest of wild cattle, the tamaru, from the Philippines, represented by a record head, the gift of Mr. Archibald Harrison. This buffalo serves more or less as a connecting species between the Bornean buffalo and the smallest of all cattle, the anoa. The horns resemble those of the more typical Indian buffaloes rather than the comparatively straight horns of the anoa. The length of this record pair is 15¾ inches.

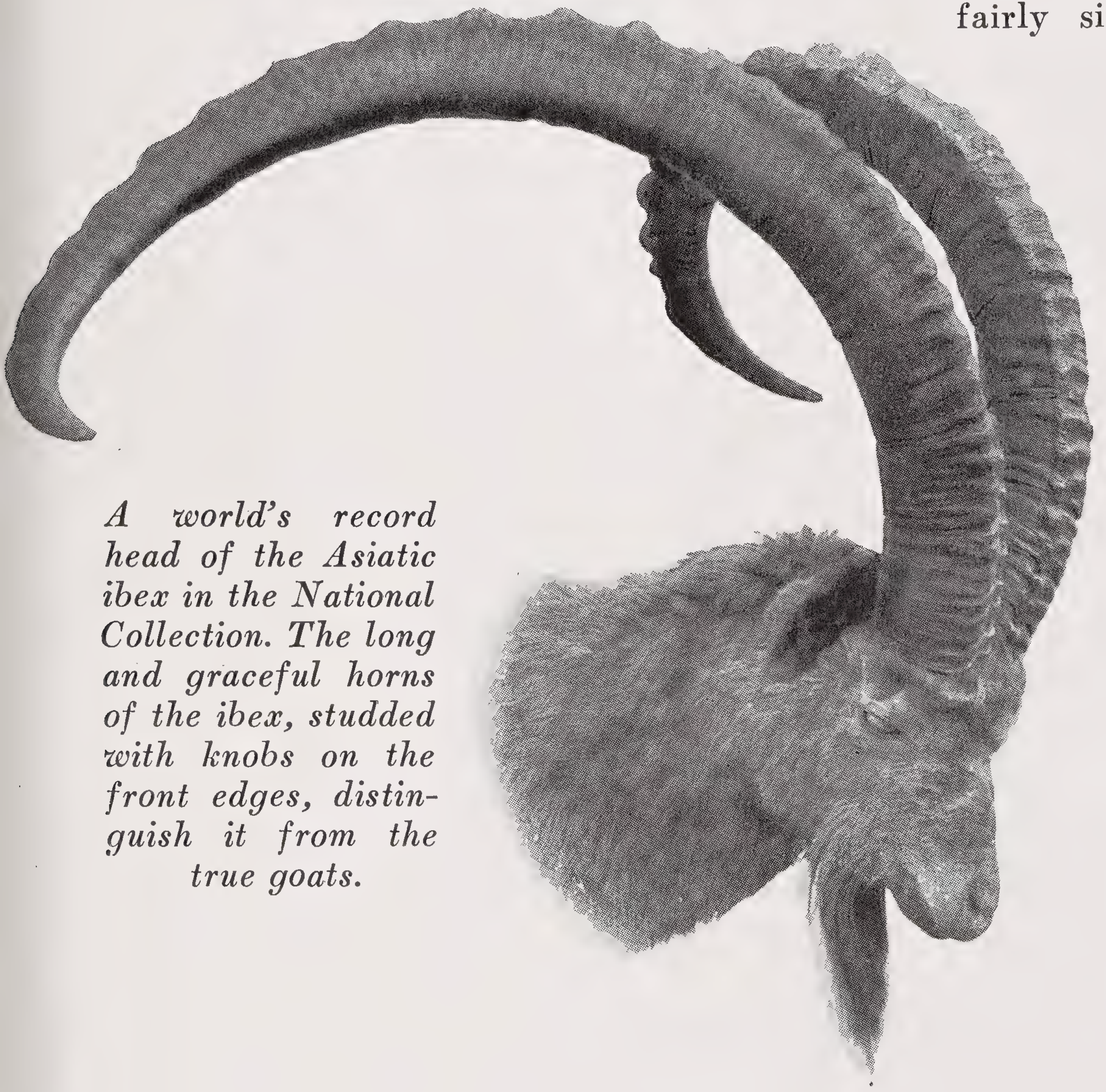
The largest of the world's cattle, the Indian bison or gaur, is represented by several fine specimens, but the prize trophy in this group is the Malay seladang. While not a world's record for size, it is an especially fine head and its great bulk conveys to the visitor an excellent idea of these giants among cattle.

The seladang differs from the gaur principally in lacking a well-developed arch or crown between the horns, and a concave forehead.

There is also a great difference in temperament. The gaur is generally shy and retiring while the seladang has the reputation of being the most dangerous of all wild cattle. It is said frequently to turn tables on its pursuers and actually hunt the hunter.

Almost all the principal species and races of the sheep and goats of the world are exhibited in the halls of the Museum. Since so many of these animals possess such strikingly handsome heads, making ideal trophies of the chase, it is easy to understand why they have led sportsmen to the far corners of the world. While the Museum possesses only one world's record in this group, the specimens shown are such fine examples of their species, and the collection is so all-inclusive, that the group is extremely well represented.

The world's record Asiatic ibex was presented by Dr. Hornaday as one of the trophies in the Nucleus Collection. In the years that have passed since that time, no better specimen has turned up to take its place. It is a typical head of the species and shows to good advantage the heavy, transverse knobs or ridges on the front edge of the horns. The horns are 58 inches long, 11¼ inches in circumference and extend 44½ inches from tip to tip.



A world's record head of the Asiatic ibex in the National Collection. The long and graceful horns of the ibex, studded with knobs on the front edges, distinguish it from the true goats.

The argalis, from the mountainous regions of Asia, are usually regarded as being the world's most handsome sheep. They are represented in this collection by a number of very fine heads. Although none of them are world's records, all are outstanding specimens and several closely approach the record heads in measurements. The romantically named Marco Polo sheep is represented by three excellent heads, and a specimen of Littledale's argali is also worthy of note. The best example of the Siberian argali dates back to the Nucleus Collection and was presented by Dr. Hornaday. It is only slightly less than an inch under the record in length and closely approaches it in other respects.

The collection of Rocky Mountain sheep is an extensive one. None of the trophies is a record head but several are among the finest of their kind, especially a bighorn in the Zoological Hall and a black mountain sheep in the Geographical Hall.

Recently an interesting specimen, the gift of Capt. Paul A. Curtis, was added to the Zoological Collection. This is the Arran goat from Holy Isle, Scotland. While it appears to be fairly similar to some present-day domestic goats, this animal has an interesting history and is said to be a direct descendant of the goats inhabiting that region in prehistoric times. Mr. Garretson's interesting note on this goat reads as follows:

"The island of Arran is situated at the mouth of the Clyde River on the west coast of Scotland with an area of about sixty-eight square miles, and is owned by His Grace the Duke of Montrose. Between the island of Arran and a rock called Gilders Craig there is a little island which is practically nothing more than a great crag of rock jutting out of the sea. This little island is known as the Holy Isle, because St. Columba, an Irish saint who is credited with having Christianized Scotland, is supposed to have lived in a cave on this island for a year or more. It is on this rocky crag that some ninety to one hundred wild goats live. They

The argalis are generally conceded to be the finest of the world's sheep and the National Collection contains a number of heads that approach the world's record, including this large and handsome head of the romantically-named "Marco Polo sheep."

are pure white in color and have a head that resembles that of our western goats, but instead of the horns being round and a shiny black, they are in form more like those of the ibex and in texture like those of a sheep."

In contrast to European sportsmen, few Americans have hunted in Africa, yet the collection of antelopes, that group of animals so typical of African plain and desert, is unexcelled. Practically all trophies on display are better-than-average and six of them have been accepted as world's records. A number of others have been regarded as records in the past but have since yielded that honor to other heads.

Antelopes comprising the Oryx group are highly prized by sportsmen because of their long, sharp, graceful horns. In the white oryx they are scimitar-shaped, while in the gemsbuck they are exceedingly long and straight. As a rule the horns borne by the males of all antelopes are larger and finer than those carried by females, but the gemsbuck reverses this rule and the female has the larger and finer horns. There are two magnificent pairs of gemsbuck horns in the National Collection and one of them was long regarded as a record.

Rocky Mountain sheep, closely related to the argalis of Asia.

A host of waterbucks is to be found in the trophy rooms of the world and the National Collection has been fortunate in securing a record head. It is a handsome, typical specimen, from Delagoa Bay. The horns are 36½ inches long, 8⅜ inches in circumference and 24 inches between tips.

Another closely related species, the lechwe, is also represented by a record head. Like the true waterbucks, this animal favors well watered country, especially swampy areas. This head, on display in the Zoological Hall, bears horns with a considerably greater spread than the average. The measurements are: 35½ inches in length, 8½ inches in circumference and 28 inches between tips.

The reedbucks are represented by a number of fine specimens. A record Sudani reedbuck is a gift of Mrs. J.

A typical and record head of the common waterbuck, from Delagoa Bay.

H. Prentice. This race is characterized by long, slender horns which have a strong tendency to turn outward, although in some instances the tips turn inward. These horns measure 17½ inches in length, 5⅛ inches in circumference and 22½ inches between tips.

Many sportsmen regard the greater kudu as the finest of all African antelopes. Certainly the long, gracefully curled horns furnish a trophy that any hunter can be proud of. The finest kudu in the collection is the gift of Mr. Harold J. Fowler. While not a world's record, it easily ranks within the first ten.

Another fine antelope trophy is the pair of Derby eland horns on display in the Zoological Hall. For a long time these were regarded as a record but they have since been exceeded by another. They represent the Congo race and were obtained in the French Congo.

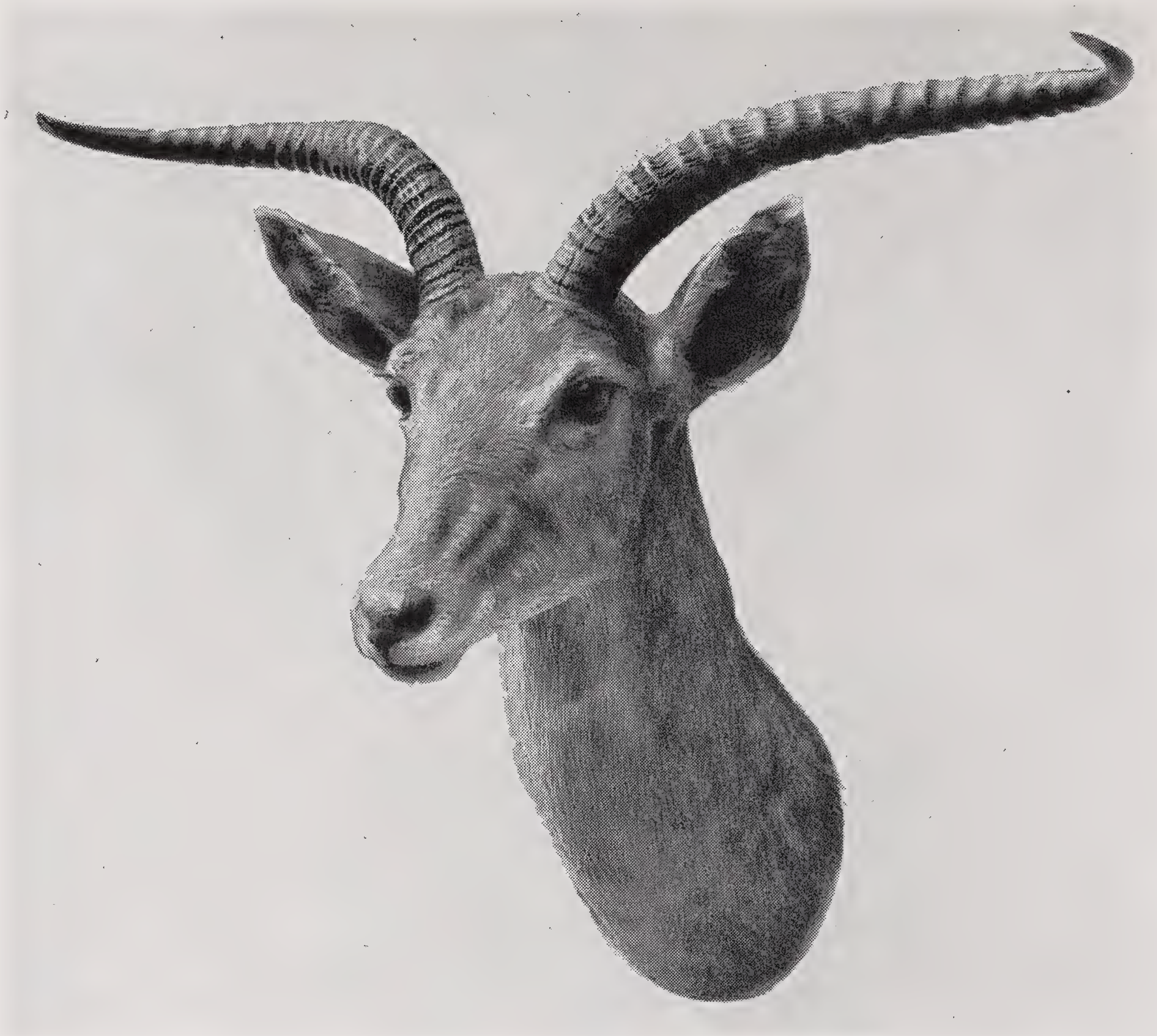
An interesting display in the Zoological Hall is made up of the smaller African antelopes, grysboks, duikers, oribis and dikdiks. It is quite apparent that many visitors to the collection were not aware of the existence of such small antelopes and as a result these little animals sometimes get a greater amount of attention than much larger and more striking exhibits. While duikers and their close relatives are so small that they are not sought after extensively as trophies, they have their place in a representative collection. A number of the specimens are close to the record for the species. Salt's dikdik, in the African collection, is a record, with horns four inches in length—really giant horns for such a tiny antelope.

Practically all species and most of the more important races of the deer of the world are found in the National Collection. North American deer are represented in most instances by exceptional heads but European and Asiatic species, including a number of rarities, are no less well displayed.

One real rarity is Schomburgk's deer from Siam. Related to the swamp deer or barasingha,

Littledale's mountain sheep, a dweller of Asia, is another well-known representative of the argalis.

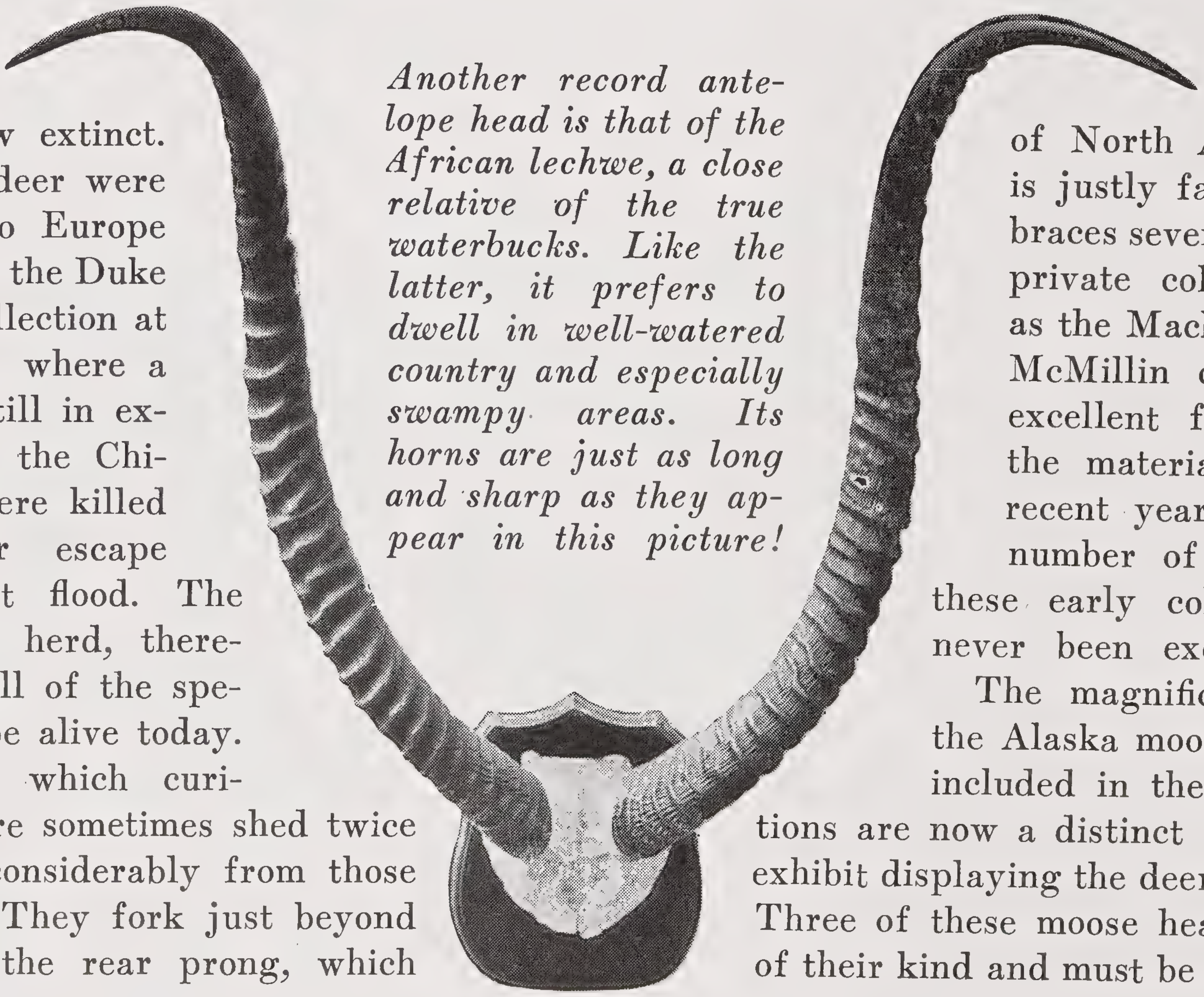
it possesses the most gracefully complex antlers of any deer. The short beam is evenly forked and each of these branches fork again to terminate in long tines. The brow tines are long, arise at right angles to the beam and usually are forked. A set of Schomburgk's deer antlers in the National Collection can, in some respects, be regarded as a record. They are 33¼ inches in length, 7¼ inches in circumference and have a spread of 36⅜ inches. They are almost perfectly symmetrical, with nine points on each side. This deer lives in a restricted area and is probably on the verge of becoming extinct. Certainly only a few more specimens can be obtained in the future.



This head of the Sudani reedbuck holds the world's record for size. Long and slender horns, with a strong tendency to turn outward, characterize this race of reedbucks.

Père David's deer is another extremely rare deer, fortunately represented in this collection. It was first described from specimens in the royal hunting park at Pekin and there is no record of it ever being obtained in a wild state, where it is now extinct. Some of these deer were brought alive to Europe and acquired for the Duke of Bedford's collection at Woburn Abbey, where a small herd is still in existence. All of the Chinese animals were killed following their escape during a great flood. The Woburn Abbey herd, therefore, contains all of the species known to be alive today.

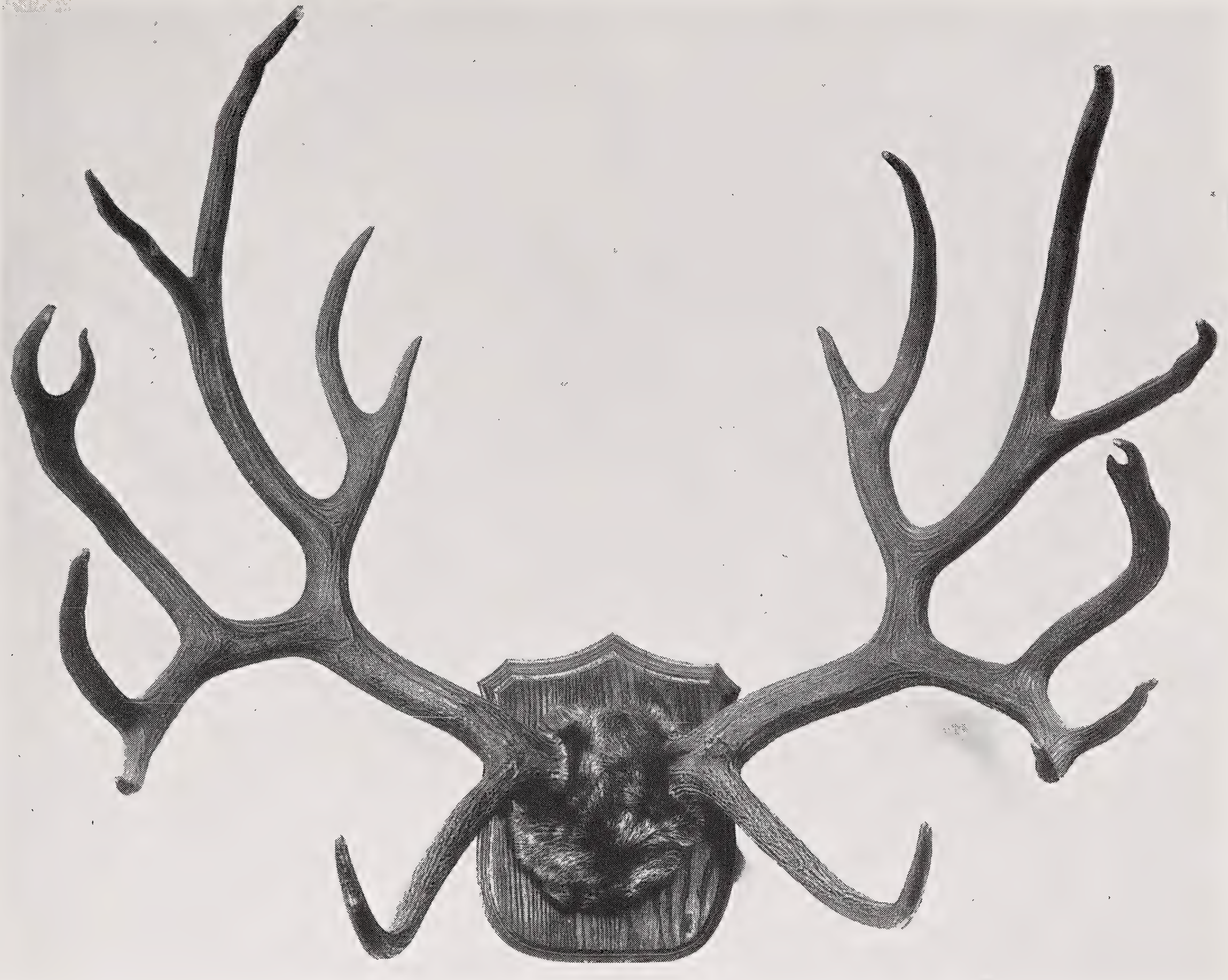
The antlers, which curiously enough are sometimes shed twice a year, differ considerably from those of other deer. They fork just beyond the burr, and the rear prong, which is very long and straight, is directed backward. The other, the ascending branch, is shorter and heavier and forks about midway to the tip.



Another record antelope head is that of the African lechwe, a close relative of the true waterbucks. Like the latter, it prefers to dwell in well-watered country and especially swampy areas. Its horns are just as long and sharp as they appear in this picture!

The National Collection's exhibit of North American deer is justly famous and embraces several well-known private collections, such as the Mackay and Reed-McMillin collections, an excellent foundation for the material received in recent years. In fact, a number of specimens in these early collections have never been excelled.

The magnificent heads of the Alaska moose which were included in the above collections are now a distinct feature of the exhibit displaying the deer of the world. Three of these moose heads are giants of their kind and must be ranked among

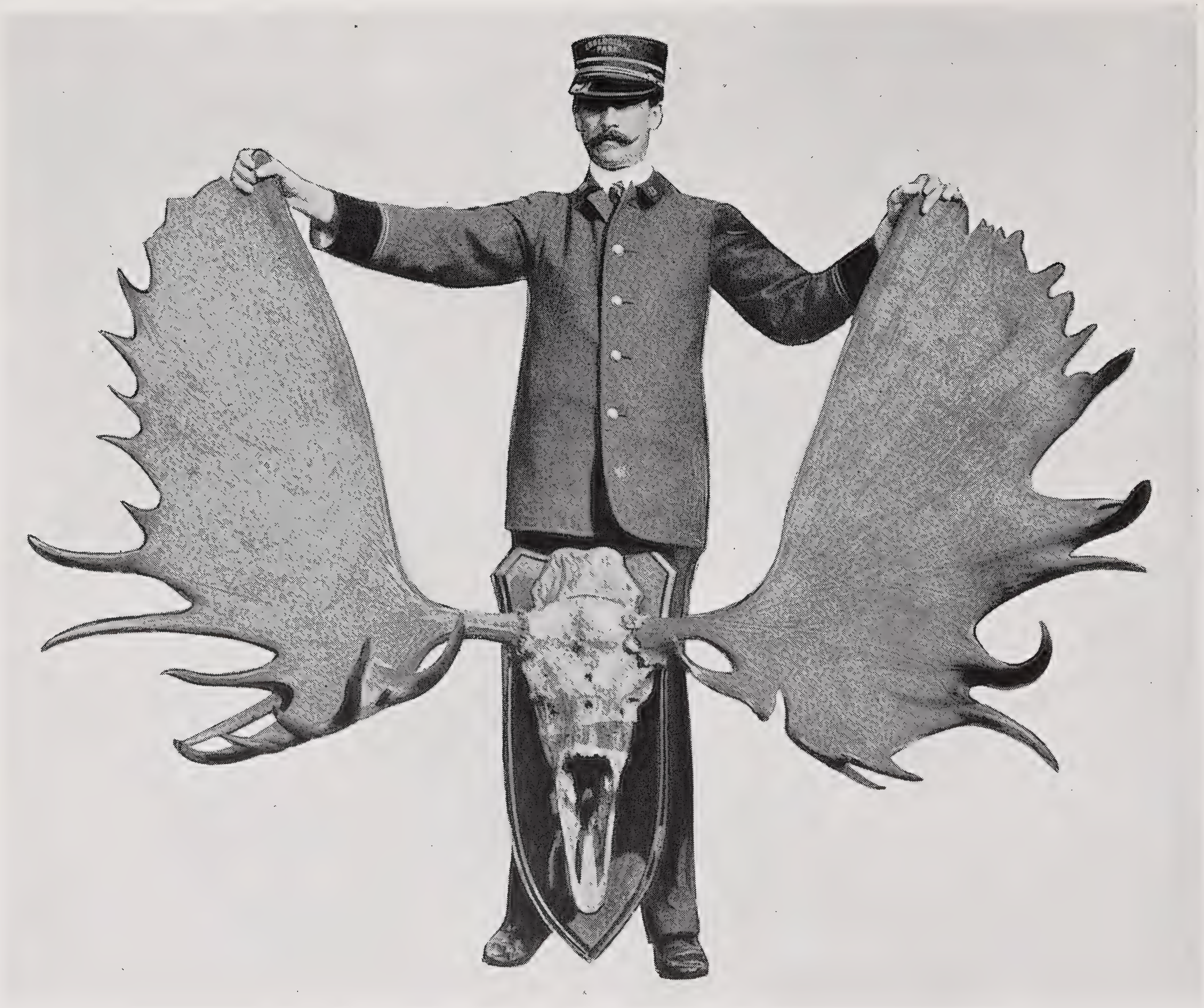


There are probably no more graceful and beautiful antlers in the world than those of Schomburgk's deer, now believed to be extinct. The specimen in the National Collection is almost perfectly symmetrical, with nine points on each side.

the best four that have ever been brought out of Alaska. The prize head from the Mackay collection is regarded as one of these records. The dimensions are: length, 42 inches; circumference, 10 inches; spread, 76 inches; greatest width of palm, 17½ inches; number of points, 13-15. Another head, from the Reed-McMillin collection, excels this specimen in a few respects but falls below it in others, thus demanding almost equal recognition. The Alaska moose is generally regarded as being the largest deer, living or extinct, and the National Collection can feel justly proud of its impressive display of these most magnificent of deer trophies.

The American moose is represented by a number of very fine heads but none is a record. Recently, an interesting specimen was obtained through an exchange with Taft School. This is known as the Bierstadt head and is remarkable for the extreme width of palm on the brow tines. Many moose heads have developed no indication of the brow tine palm but here it reaches a width of 13½ inches.

The various species and races of the caribou furnish some of the finest trophies of the chase that can be obtained on the North American continent. The National Collection is again indebted to the Reed-McMillin collection for its superb display of caribou heads. Every sportsman knows that it is now practically impossible to obtain heads that are much better than average. The finest trophies were secured around



One of the four famous Alaska moose heads in the National Collection. The extreme width of the palm in relation to the length is to be noted as one of its outstanding characteristics. The head is from the Reed-McMillin Collection.

the turn of the century, when the Reed collection was assembled, and most of these early specimens are still among the best of their kind.

The woodland caribou is represented by an exceptionally fine head, not a record, but much better than the average obtained today. This typical race of the caribou is the most southern and eastern representative of the species and the only caribou to be found within the borders of the United States. There are now few survivors of the numerous bands that were to be found in colonial days, and it is a pity that some of the better specimens of that time could not have been preserved.

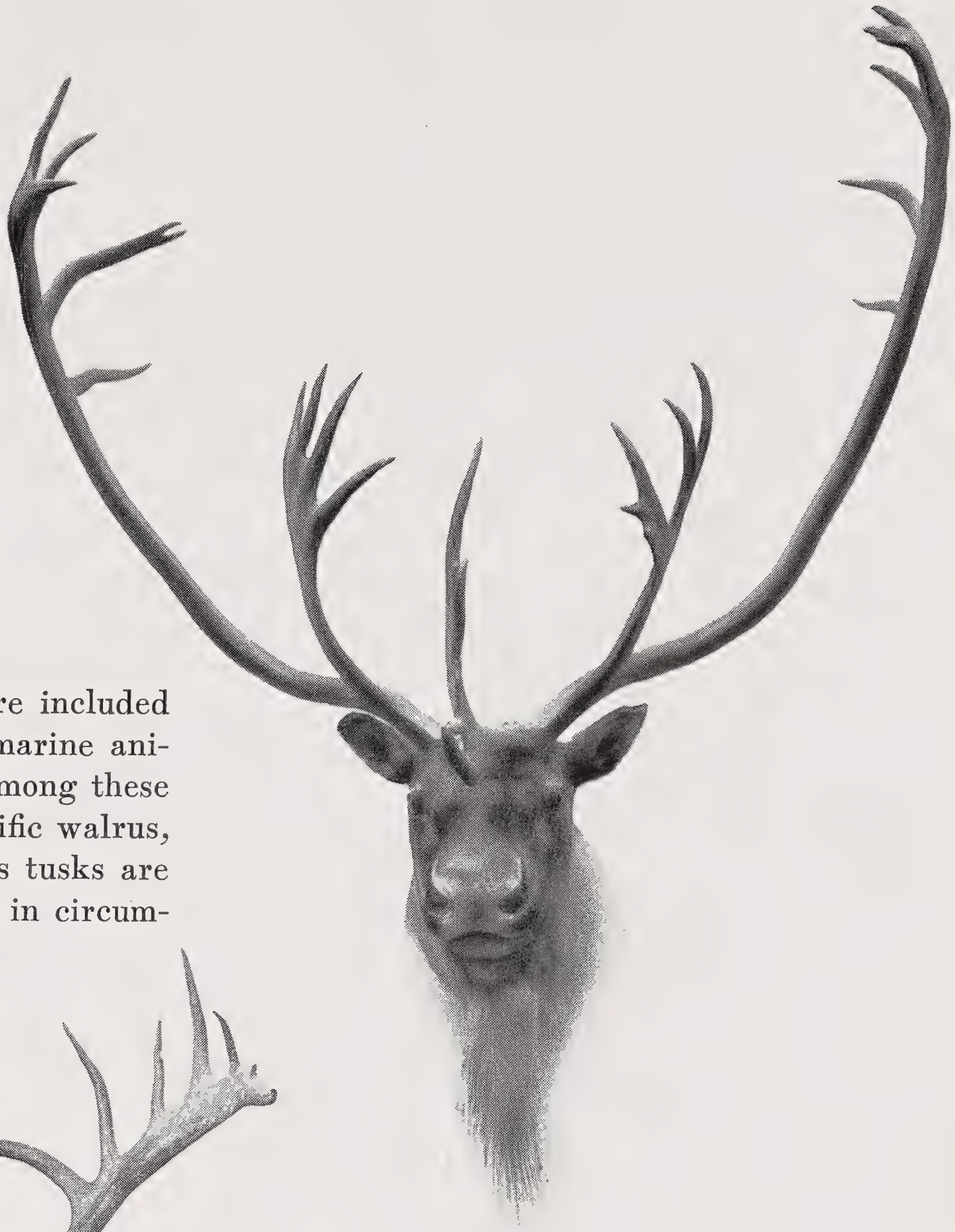
The Osborn and Grant caribous are of special interest to members of the New York Zoological Society, since they were named in honor of two founders of the Society, Prof. Henry Fairfield Osborn and Mr. Madison Grant.

The Osborn caribou, the largest of all caribous, belongs to the mountain caribou group and has relatively large, distinctly flattened antlers. A record specimen of this species is the gift of Mr. F. C. Havemeyer. It is 62¼ inches in length, 7½ inches in circumference, has a spread of 43¼ inches and its points are 18-16. Another and almost equally fine set of antlers is found in the Reed-McMillin collection.

The Grant caribou, one of the Barren Ground caribous, is represented by several outstanding heads from the Reed-McMillin collection. The record head measures 62 inches in length, has a circumference of 8⅜ inches, a spread of 50 inches and its points are 12-9.

The caribou collection was rounded out by the recent addition of a good head of the Newfoundland caribou, the gift of Mr. Grover E. Asmus. This caribou belongs to the woodland caribou group. It is larger than the typical species and much lighter in color. The antlers have a wider spread and the branching is more complex.

Other large and impressive hoofed animals such as the rhinoceros, hippopotamus and giraffe are included in the National Collection. Several marine animals help to round out the series. Among these we find a record specimen of the Pacific walrus, the gift of Mr. Henry A. Caesar. Its tusks are 36¼ inches in length and 9⅞ inches in circumference. There is a unique and rare narwhal, which instead of the usual single tusk, has two of these long, spirally-turned lances of ivory. The "combat group" of locked antlers of fighting deer is another exhibit that invariably interests visitors, as does a small collection of old hunting guns. As a last thought in discussing the National Collection of Heads and Horns, it can be said that the dream of the founders is being realized. Here in adjacent halls have been gathered together two great collections of sportsmen's trophies, systematically arranged and truly representative of the "Vanishing Big Game of the World."



Grant caribou, a representative of the Barren Ground caribou.

Osborn caribou, one of the group of mountain caribou.

What Makes a "Record" Head?

M. S. Garretson

Curator of the National Collection of Heads and Horns

EVERY sportsman and big game hunter will recognize the truth of the assertion that present methods of determining just what measurements of horns and antlers are necessary to establish a "record" leave something to be desired in the way of distinction and consistency. This article is an inquiry into some of the methods now employed and a suggestion for combining the elements that make for "record" size so that they may be given their proper weight in determining which is actually the finest of a given series of trophies.

The basis of any attempted scientific system of measurements of this kind must be the "typical" form of the horn or antler, disregarding malformations and freaks.

As there are many variations in the pattern of horns and antlers, especially the latter, the question naturally arises as to what constitutes a typical specimen of any particular species. A reasonable answer and the one most widely accepted is that when, after careful study and observation, it is discovered that the majority of antlers of a given species closely resemble a certain pattern, it is to be assumed that this pattern, with no great variations, can be accepted as typical of that particular species.

The value of a horn trophy is largely determined by two important factors, viz.: its resemblance to type, and its dimensions.

The majority of big game hunters usually endeavor to obtain as fine a specimen of the species as possible, especially the horns, which occasionally may be classed as a record for size. However, no one dimension should determine whether a head is the best over all in the record. As a record denotes a condition which goes beyond or is extraordinary among others of its kind, it is therefore necessary, in order to determine accurately if this is so, to take certain measurements, but in the absence of any established standard as to which one of the several measurements constitutes a record for the whole, the matter is more or less confusing.

In the recent publication of "Records of North American Big Game," edited by the late Prentiss N. Gray, he acknowledges the fact that no one dimension should be the controlling factor in establishing a record. Nevertheless, in his tabulation he has in some cases placed length above all other dimensions while in other members of the same family group, the greatest spread leads the list.

It is the usual custom when measuring horns and antlers to ascertain the length, circumference and spread; and for antlers, the number of points and width of palm. These are the principal measurements that are of any great importance in determining a record. At present there is no established rule as to which dimension should take precedence, but it is generally conceded that as length usually governs the size, length should carry considerable weight. This applies in most all cases except the moose, whose antlers vary greatly and where length is of less importance than the palm, which is the largest and most outstanding feature. Therefore it seems reasonable that width of palm should be of first consideration instead of spread. While the spread is of interest, it can hardly be accepted as being of superior importance because it simply records the position and not a dimension of any part of the antler. Inferior moose antlers, owing to an extra long or freakish point, could easily lay claim to being a record—and no doubt are, insofar as spread is concerned. But if, in all other respects, they do not compare favorably with a good typical specimen of the species, they should not be rated over and above all others simply on account of position.

It has been suggested that an important point for consideration is the amount of bulk or horn material, but there are reasons why bulk is of no great importance in judging a horn trophy. The beauty or pattern is not determined by the amount of material it contains. An oil painting is not judged or valued by the amount of paint on the canvas, but rather according to its proper distribution. And so it is with horns. A very inferior type of horn could easily qualify in the matter of bulk but otherwise be of little value as a trophy.

If horn trophies were a commercial commodity and were sought for the amount of material they contained, irrespective of how distributed, then bulk would be of some importance, but bulk is a matter of quantity and not a dimension.

In order to avoid confusion, the circumference of an antler or horn should be taken at its base. In antlers it should be taken just above and close to the burr, just as a tree is measured. If taken anywhere else, the measurement should be so specified, but placed secondary to the base dimension. Circumference of the burr itself is of small importance because of the great irregularity of the nodes or points.

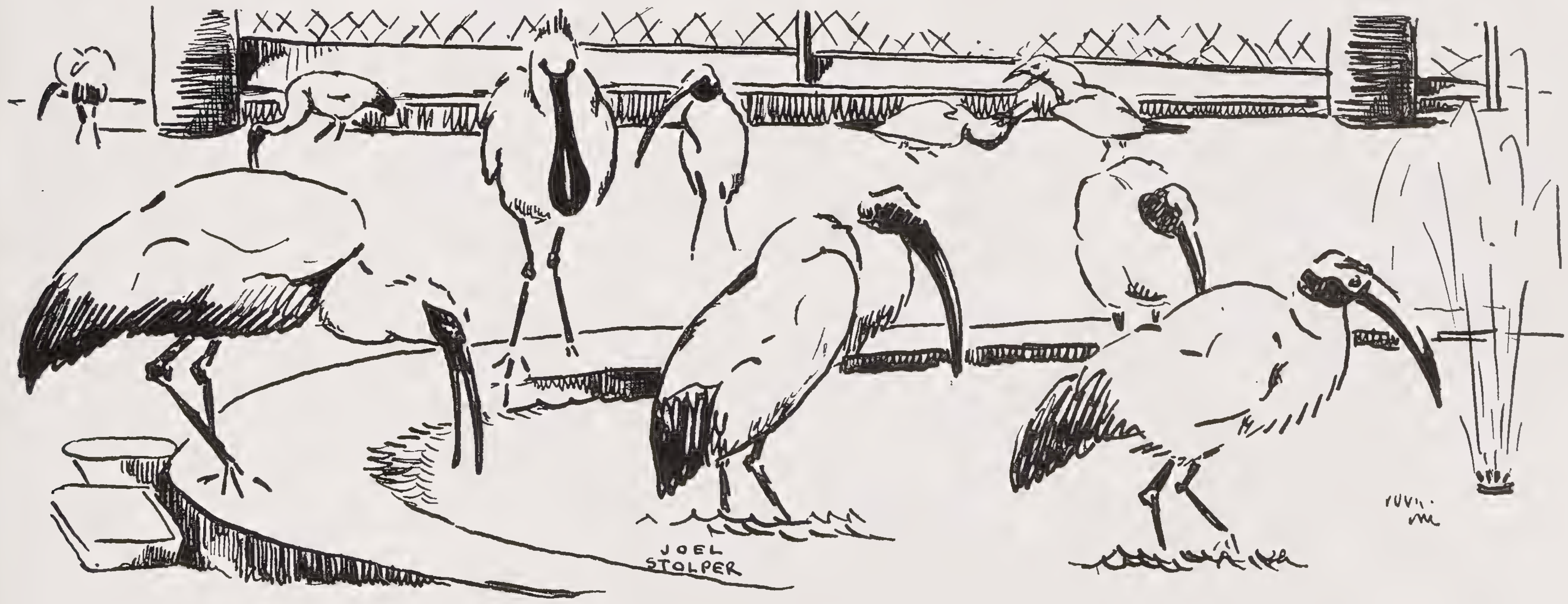
Owing to the peculiar base pattern of horns on the musk ox and Cape buffalo, width of base may be substituted for circumference.

It is doubtful if any antler trophy can be classed as a "World Record" unless it equals or exceeds in all the principal dimensions, viz: length, width of palm, circumference, number of prongs and spread. In each case where a record for a single dimension has been obtained, it would be more enlightening if a symbol was used denoting the particular part which is a record. This could be done by using a small star in published records or on museum walls; a perpendicular line attached to the bottom might denote length, a horizontal line on both sides of center, the spread; on one side only, width of palm. Such marks would indicate graphically the specimen's true position in the list of records.

Field measurements taken at the time an animal is killed are of some interest, but because of shrinkage they cannot be relied upon for any length of time. In order to avoid any suspicion of exaggeration, official measurements for comparison should not be taken during the period of shrinking which occurs during the first year and is governed largely by the temperature of the surrounding atmosphere.

The old theory that the age of a deer can be determined by the number of prongs or points on the antlers cannot be depended upon with any degree of accuracy because deer often grow more than one prong a year, and then again produce the same number of prongs for several years in succession; their growth also depends upon the forage, and when this is scant the antlers do not develop as well as when it is abundant. The average life of a deer is from 15 to 20 years. Many antlers are found having more than 40 and 50 points, and at least two whitetail deer are on record which had more than 70 well developed points. As a rule, the best-developed antlers are grown during middle life. After that they start to decline and frequently have less points than when the animals are in their prime.

The most reliable way to determine the age of deer is by the teeth. They get their permanent teeth at about the age of three, and as these gradually wear off, their condition will usually give a fair estimate of age.



The Whale Shark at Acapulco, Mexico

The Occurrence of this Giant Shark in a New Locality

E. W. Gudger
Bibliographer and Associate Curator of Ichthyology, American Museum of Natural History
and Ralph L. Smith
Mexico City

(Photographs from Mr. Ralph L. Smith)

BECAUSE of its great rarity (only 76 specimens are on record as of January 1, 1935), the capture of this giant among sharks and the establishment of a new locality for it are matters of no small interest to the student of fishes, and indeed to all interested in natural history.

While this is the first record of the capture of this fish for Acapulco, it is not the first for the western coast of Mexico, nor for the western coasts of the Americas. In 1865, Theodore Gill put on record a specimen captured in 1858 at an undesignated locality in the Gulf of California. In 1927, two specimens were noted by Gudger as captured at Guaymas, about half way from the head to the mouth of the Gulf. In the same year eleven whale sharks (some possibly duplicates) were recorded by the senior author as seen and some photographed at or near Cape San Lucas, Lower California. Further south, a specimen was taken in Panama Bay in 1884. Two specimens have been reported from the Galápagos islands, one in 1927, the other in 1933. Farthest south is the record from Callao in 1878.

To these records are now to be added five specimens of the whale shark taken at Acapulco, on the Pacific Coast, about under the meridian of 100° west longitude; one in 1932, the others in 1933.* The data for these were secured by Ralph L. Smith on various visits to Acapulco in 1933. All were harpooned by the best fishing captain of the port, Francisco Moreno (commonly called Pancho). None offered any particular resistance other than swimming and sounding. Pancho used two harpoons, one on seven-eighth-inch hemp rope and the other on

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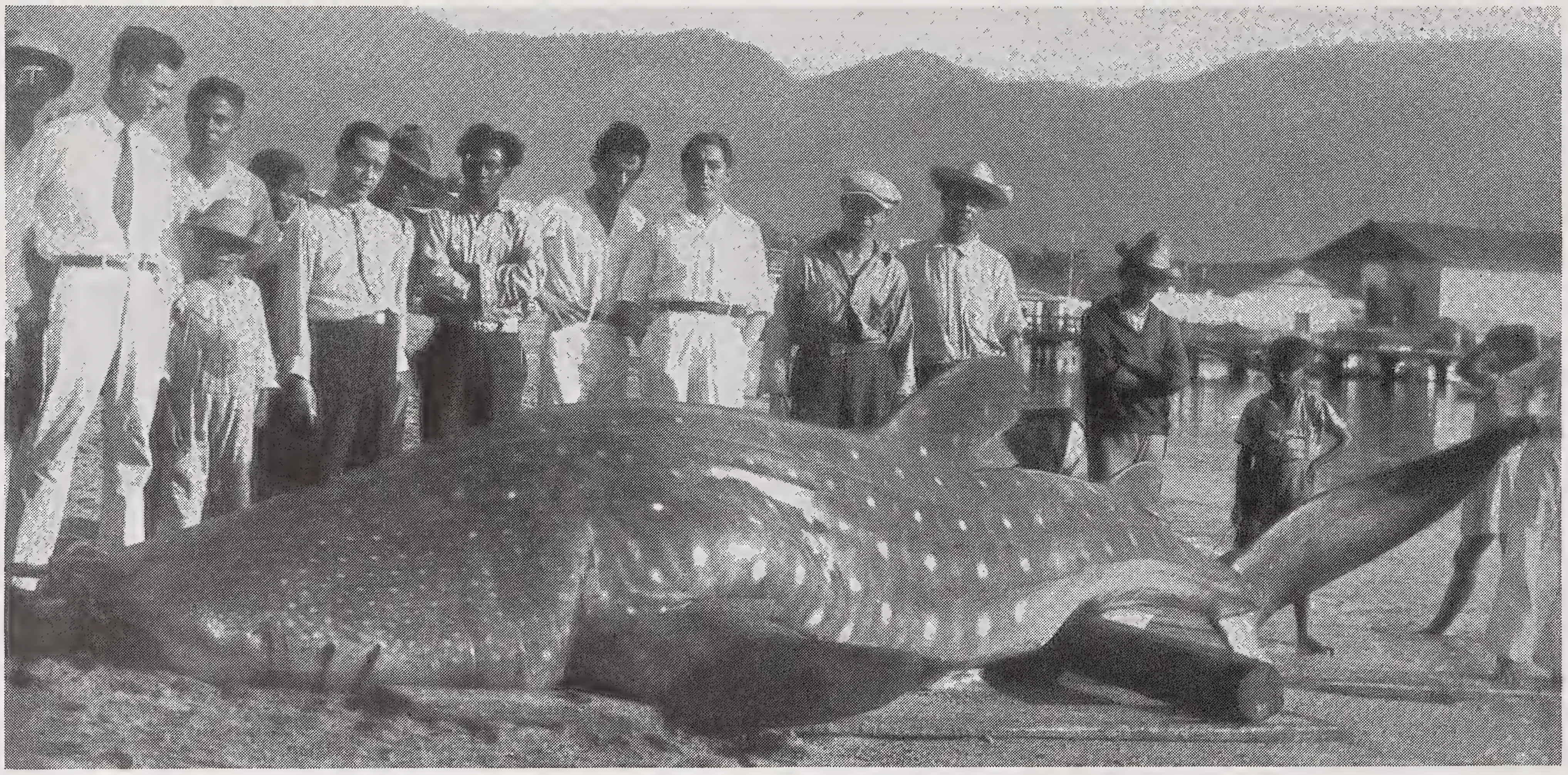
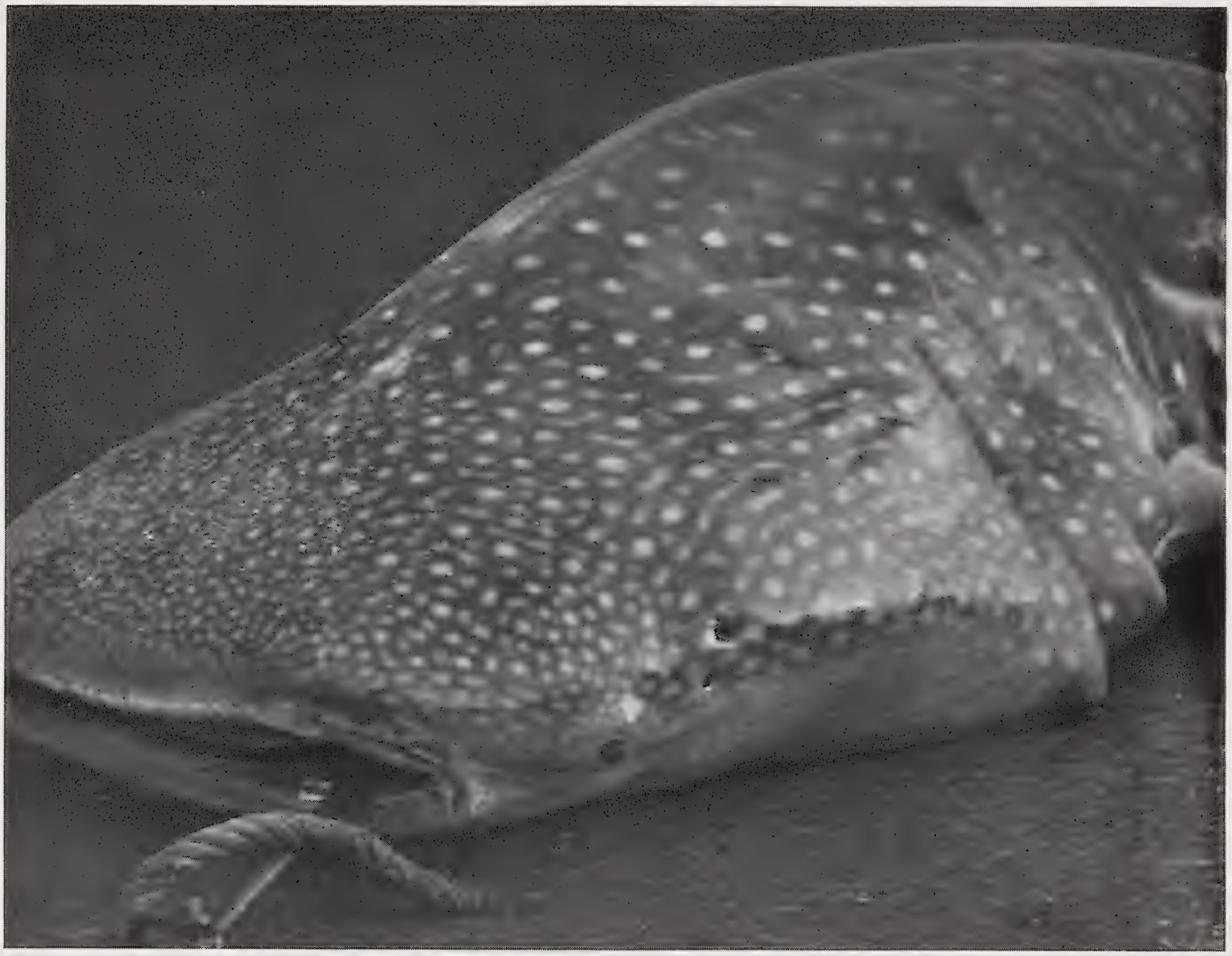
* Since the above was written, Pancho has taken another *Rhineodon* near Acapulco. It was about 15 ft. long. This raises the Acapulco record to six. Its skin has been purchased by the American Museum. It is of great interest to note the relative prevalence of this great fish on the west coast of Mexico.



Whale Shark No. I. This Rhineodon typus *was captured in the harbor at Acapulco, Mexico, and dragged onto the beach on rollers running over heavy skids.*



Whale Shark No. II. Head and mouth of Rhineodon typus, *the greatest and most harmless of sharks. The terminal mouth is as wide as the head and the teeth are so small they are not visible in the picture. At the left are seen the eye, the double spiracle and the huge gill-slits, the latter exceeded in size only by the basking shark.*

five-eighth-inch rope. The procedure was practically the same for all captures.

All were harpooned off the Pie de la Cuesta, which is a long sand bar between the sea and a lagoon starting about ten miles north of Acapulco harbor. All were found swimming around at the surface 250 to 500 yards from the shore where the water is about five fathoms deep. Pancho uses first the harpoon with the heavy line. When struck the great shark goes down and out with a rush. When it has taken about 200 feet of the line, this is snubbed. The launch for a while follows the shark under her power, but gradually this is cut off and the boat then serves as a drag. After about an hour and a half the giant becomes so tired that the launch is hauled up to the shark as it threshes about and the other harpoon is thrown. The fish then generally dives again, but with two harpoons and lines attached, the drag can be increased. After about an hour the fish becomes pretty well spent, the boat is hauled up, a line is fastened around the tail, and the great shark is towed into port by the thirty-foot launch. Pancho once tried to get a big hook into the mouth of a *Rhineodon* but it was bent out of shape. The sharks are brought in alive and beached on the sandy shore.

Acapulco whale shark No. 1 (a female) is shown opposite. This excellent photograph shows well the head with the eye, the three ridges along the side, the size and shape of the fins—particularly the tail fin. Here we note the long upper lobe and the relatively short lower one.

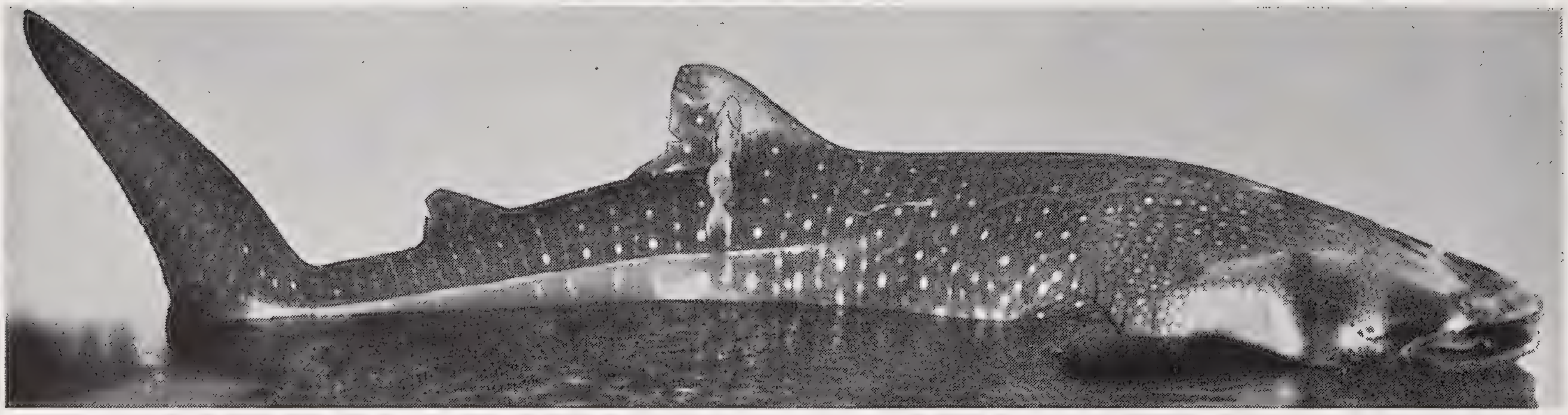
The lowermost of the three lateral ridges runs onto the tail, adding much to its strength. It looks as though there is the well known "caudal notch" on top of the tail where the upper lobe of the caudal fin arises. A hole has been bored through the head just behind the jaws and a rope inserted. By means of this the fish was drawn up on shore on rollers operating on heavy boards.

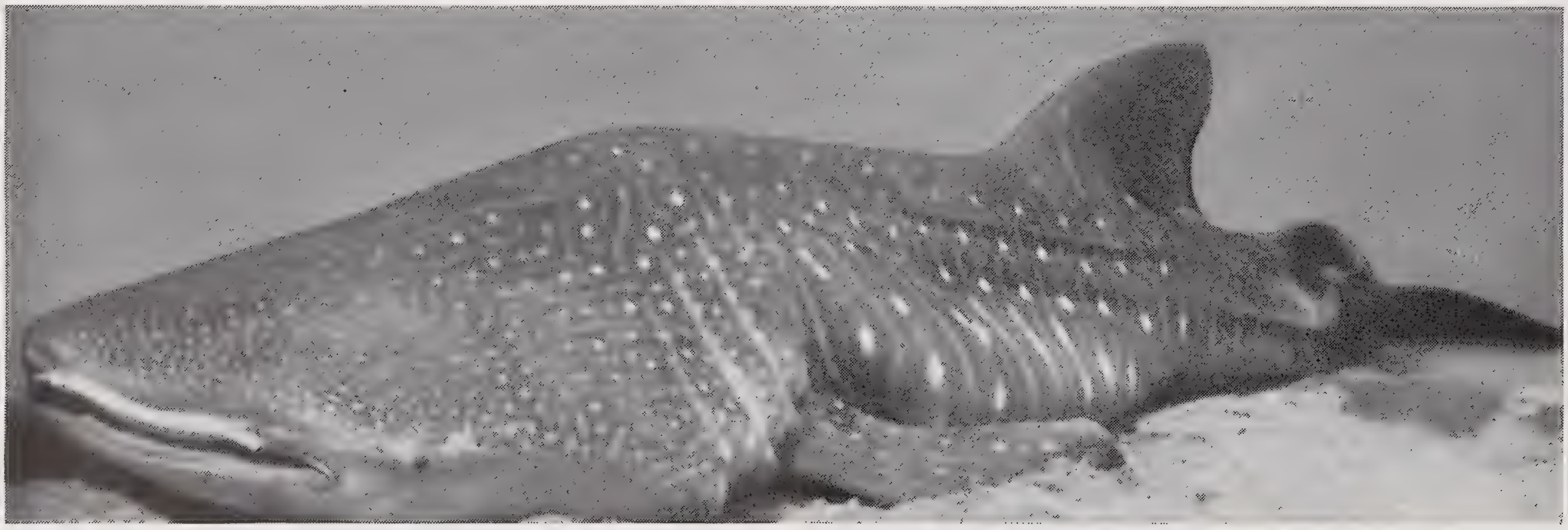
We possess in the American Museum the largest collection in the world of photographs of the whale shark, and that reproduced on Page 68 is rivalled by but one other.

The head only of whale shark No. II is portrayed on Page 69. Note that the whale shark has a terminal mouth as wide as the head. Most sharks have mouths on the under side of the head, hence the erroneous idea that a shark must turn on its back to bite. Behind the angle of the jaw the eye is seen—very small in proportion to the great size of the fish. Further back are the enormous gill-slits—exceeded in size only by those of the basking shark, another giant of the seas. The fish seems to have been drawn ashore by an anchor inserted in its mouth.

The skin of the head has been much scuffed up, indicating that the head was much battered in the process of capture. But despite this fact, this photograph more clearly than any in our large collection shows all the structures of the head in fine detail. The fish was a female.

Whale shark No. III is shown in lateral view. This fish, unfortunately the only one measured, was about nineteen feet long. The general appearance of the fish is well portrayed. Of especial interest are the upper lobe of the tail fin and the large sucking fish which came ashore with its host. These curious fishes are generally found stuck fast to the outside of the host but are quite as often found adherent to the inside of the cavernous mouth. This specimen was a male.

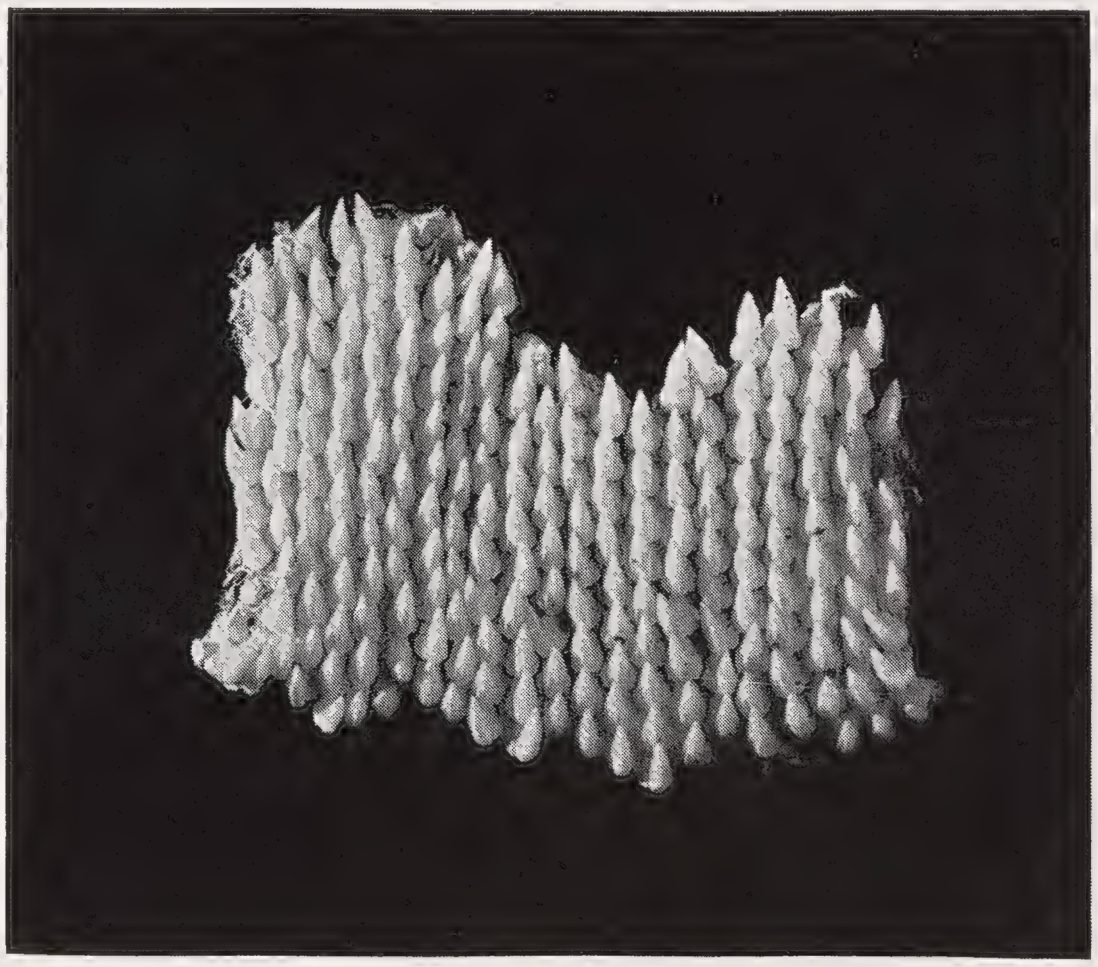




(Top) Whale Shark No. III. Lateral view of the third Acapulco whale shark. The markings are the most unusual and characteristic of those on any shark. This specimen, about 19 feet long, is not more than half grown. A suckingfish that came ashore with its host is shown attached to a fin. Sometimes it clings inside the mouth.

(Bottom) Whale Shark No. IV. The intricate wavy pattern of the head markings is an unusual and possibly unique variation among the Acapulco whale sharks.

Fish No. IV, seen below, shows well all parts of the great fish, especially the anterior ones. Well shown are the terminal mouth; and also the eye, nostrils, and huge gill-slits on the left side. Furthermore, better than any other photograph of the whale shark we have ever seen, this one shows an interesting variation: the curious and intricate wavy markings on the broad head. In fact, these figurings seem to be unique, since none other of the photographs in the Museum collection shows them so markedly. Pancho says this fish was also a male. Unfortunately the pelvic fins, which enable one at a glance to determine the sex, are not shown in the photograph.



A fragment of the tooth-band of a whale shark, natural size. The teeth are an eighth of an inch long, and there are about 6,000 in each jaw. (Photo from American Museum.)

Our photographs of fish No. V are too small to be reproduced. However, they show practically nothing not already seen in our other photographs. This specimen was skinned and the skin is now in Mexico City.

Before passing on, attention must be called to the fact that these Acapulco whale sharks are all undersized, below the average. Adults run from thirty to forty-five feet. Judging by the relative size in the photographs of the persons standing by, these specimens are from fifteen to nineteen feet long—the latter being the size of the only one measured. From the fact that these are young fish, and from the judgment that the young must be about five feet long when born, the interesting conclusion may be drawn that the whale shark breeds on the southwest coast of Mexico.

At Acapulco the whale shark is called the "Tigre del Mar," the tiger of the sea. On a basis of coloration, the most distinct and unusual of any shark known to us, the whale shark is well named the tiger of the sea. But, from a standpoint of ferocious habits, it is a total misnomer. With a mouth large enough in our specimens to contain a good-sized boy, opening to the exterior with jaws stretching from one side of the head to the other, this greatest of all fishes is the mildest mannered shark that swims the seas. Each jaw is provided with a wide tooth-band of many thousands of backwardly recurved teeth, each about an eighth of an inch long. A specimen of the toothband of a *Rhineodon typus* from Florida is shown on this page.

The food of the whale shark consists of small fish, swimming crabs, jellyfishes, and all the other surface-living sea creatures included in what is called the plankton. These small things, filtered or sieved out by the whale shark's close-set gill-rakers, constitute the food of the greatest fish in the seas. The gullet, through which this food passes to the great stomach, is only about large enough to take a man's fist. Hence the food of our great shark must be small.

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All pictures not otherwise credited are from the photographic collection of the New York Zoological Park.

A Tragic Month

THE first month of this year was a tragic one for the New York Zoological Society in that it suffered successively the death of Mr. William White Niles on January 12, of Mr. George D. Pratt on January 20, of Mr. Henry deB. Parsons on January 26, and of Mr. Prentiss N. Gray on January 31.

A resolution expressing the sorrow and sympathy of the Executive Committee on the death of Mr. Niles, Secretary and Trustee of the Society, was published in a previous BULLETIN. Subsequently similar resolutions were adopted on the deaths of Mr. Pratt, Mr. Parsons and Mr. Gray.

Mr. Pratt was a member of the Board of Trustees and was a Founder in Perpetuity. For years he had shown an eager interest in the Society and contributed liberally to its activities, particularly to the Heads and Horns Museum and to the Department of Tropical Research.

Mr. Parsons, also, had been a member of the Board of Trustees for many years and in addition, as Consulting Engineer, gave generously of his time and talent to the early development of the Park buildings and exhibition structures.

Mr. Gray died in a boating accident in the Gulf of Mexico, off Everglades, Florida, presumably on January 31. As chairman of the Heads and Horns Committee he had been actively engaged in obtaining authentic records of big game animals and in soliciting such trophies for the National Collection.

Belgium Helps

THE International Office for the Protection of Nature, at Brussels, announced under date of February 7 that the Belgian Government has by royal decree officially recognized the International Office and has appointed four representatives to the General Council.

The delegates for Belgium are Baron E. de Cartier de Marchienne, Belgian Ambassador in London, and Count Henry Carton de Wiart, former Prime Minister. Delegates for the Belgian Congo and the Mandated Territory of Ruanda-Urundi are P. Charles, Minister of Colonies, and Dr. V. Van Straelen, director of the Royal Belgian Museum of Natural History and president of the Institute for National Parks in the Belgian Congo.

2,886,000 Pounds

ON Monday, March 4, just 35 years and six months less two days after he came to the Zoological Park as its cook, Rudolph Bell retired from the Park's service on a pension. When he became cook on October 6, 1899, the duties were not onerous; a pound of hamburger steak and a quart of milk sufficed for the animal collection each day. In later years the job was not quite so simple and Bell estimated that in 35 years he handled 2,886,000 pounds of meat and uncounted quantities of other food. He was succeeded as Park Cook by James McQuade.

Early Spring

ON February 28, seventeen days earlier than ever before, the Curator of Birds saw six flight robins in the Zoological Park and thereby became the first to announce the arrival of spring in New York City. Two days before Dr. Blair heard song sparrows singing—another sign of spring, since they are silent during the winter months. Isolated robins may spend the winter in the city's parks where small patches of food are available and sometimes eager bird-watchers spy them in January or early February and hail them as harbingers of spring, but it takes more than one robin to make a spring.

PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-VI and Volume VIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Published by the Society

Heads and Horns Brochure: A picture catalogue of the collections in the Heads and Horns Museum. Numbers 1 and 2 are completed, but publication is temporarily discontinued. $1. (16 *oz.*)

Official Guide Book to the New York Zoological Park (*Hornaday*). Twenty-fourth edition, completely revised. Profusely illustrated. 50c. (15 *oz.*)

Animals: Art Stamps. 32 pages; 120 colored stamp illustrations. 85c. (13 *oz.*)

Child's Book: Wild Animals. 96 pages; 50 colored illustrations. $1. (12 *oz.*)

Panorama: Bird's-eye View of the Zoological Park. 15c. Postage 3c.

Photographs, enlargements, photogravures. At various moderate prices.

(*Postage Extra, According to Weight and Zone*)

Aquarium Publications

Official Guide to the Aquarium Collections (*Townsend*). Third edition. Profusely illustrated. 50c.

Cultivation of Fishes (*Townsend*). 27 pp.; 17 illus. 35c.

Porpoise in Captivity (*Townsend*). 11 pp.; 14 illus. 30c.

Galápagos Tortoises (*Townsend*). 82 pp.; 45 illus. 60c.

Marine Fishes (*Nichols-Breder*). 192 pp.; 263 illus. $1.40.

Fishes in the Home (*Mellen*). 178 pp.; 63 illus. $1.10.

The Public Aquarium (*Townsend*). 97 pp.; 47 illus. 85c.

Color Changes of Fishes (*Townsend*). 58 pp.; 11 text figs.; 27 color plates. $1.10.

The Fur Seal of the California Islands (*Townsend*). 8 pp.; 11 text figs.; 1 color plate. 75c.

Growth and Age in the Giant Tortoise of the Galápagos (*Townsend*). 8 pp.; 13 text figs. 40c.

Tropical Fishes as Pets (*Coates*). 226 pp.; 56 illus. $2.50.

Postcards: General Exhibits. Set of 12, colored. 35c.

Postcards: Tropical Fresh-water Fishes. Set of 12, colored. 35c.

For all Aquarium publications or any work relating to aquatic life, address the New York Aquarium, Battery Park, New York City.

(*Postage Included in Price*)

A classified list of the publications of the Society, with subject headings of articles printed in the *Reports, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. MITCHELL, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

Clark and Fritts, New York, Printers.

NEW YORK ZOOLOGICAL SOCIETY

. XXXVIII, No. 3 May-June, 1935

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

SMITHSONIAN INSTITUTION
NATIONAL MUSEUM

590.673

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EVER since its founding in 1895 the New York Zoological Society has attracted the active interest of persons who believe, with the founding group, that instruction and entertainment and important scientific achievement can go hand in hand through the maintenance in New York City of well-balanced collections of mammals, reptiles, birds and fishes from all parts of the world.

The Society is taking a prominent part in the conservation of wild life all over the world but especially in North America. The work it has done in the collection of Heads and Horns is of great scientific value as are the accurate pictures of wild life in its galleries.

In the Society's work of gathering, maintaining and exhibiting its collections, as well as its constant efforts in behalf of conservation of wild life everywhere, every Member shares, and through the privileges of Membership and the Society's publications is rendered an accounting of the work in which he participates.

The New York Zoological Society invites the Membership of all persons who wish to lend financial support to the purposes for which the Society was founded and to cooperate in a tangible way toward the future development of the Zoological Park and the Aquarium.

Annual Membership in the Society is $10, renewable annually. Life Membership may be obtained for $200. A contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

All classes of Members are entitled to receive every periodical publication, the privileges of the Administration Building with its lounges and reception rooms and gallery of paintings of animals, to attend lectures, open meetings and entertainments, and to be admitted free to the Zoological Park and the Aquarium every day in the year.

Application for Membership may be made on the inserted form, may be given to the Director of the Zoological Park or the Director of the Aquarium, or may be mailed directly to the Secretary, New York Zoological Society, 101 Park Avenue, New York City, for action by the Executive Committee.

The Zoological Park is open every day in the year from 10 o'clock in the morning to one-half hour before sunset. Admission is free every day except on Mondays and Thursdays when an admission fee of 25 cents is charged for adults and 15 cents for children between the ages of five and twelve. These days have been set aside primarily for the benefit of Members and their friends, who are admitted free on tickets issued with Membership, so that the collections may be seen to the best advantage. All holidays are free.

The Aquarium also is open every day in the year. From April 1 to September 30 its hours are 9 o'clock in the morning to 5 o'clock in the afternoon, and for the remainder of the year, from 9 o'clock in the morning to 4 o'clock in the afternoon. No admission is charged at any time during the year.

The Animal Hospital is secluded and quiet, for restfulness is as important to animal patients as it is to sick humans. It is here that new arrivals are quarantined and the all-important diets formulated.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

Vol. XXXVIII May-June, 1935 No. 3

The Animal Hospital

Charles V. Noback
Veterinarian, New York Zoological Park

DURING all periods of recorded history man has been interested in wild animals, as may be seen by consulting the records of the Babylonians, Egyptians and Romans. The earlier collections of living wild animals were not so extensive nor representative of the animal species of the world as those found in modern zoological parks. The zoological gardens of today were made possible by the rise and development of our modern means of transportation and the development of modern methods of animal sanitation and disease prevention.

The life of wild animals in their native habitats is not always tranquil and peaceful, for each of them has visible and invisible enemies to overcome in order to survive. Droughts, floods, severe winters, climatic changes, predatory enemies, parasites and disease are some of the unfavorable conditions which confront them.

The significance of parasites was recently brought to the attention of the writer when he was called upon to examine a bushmaster that had died. This venomous reptile may have been "the master of the bush," as its name implies, yet despite the fact that it had been fed on the choicest of food and given the best of care, it did not survive. Examination revealed that it carried the seeds of its own destruction within its body, in the form of a variety of parasites acquired in its native environment. One of the bushmaster's parasites, a linguatulid, equipped with four sharp claws, had literally embedded itself in the heart muscle of its victim.

When conditions are favorable, animals obviously increase and multiply. The constant adjustment of animals to food supply, predatory enemies, disease and other conditions of their environment brings about a state known as the "balance of nature." Because the stress and strain of life is so great, wild animals in their natural state do not as a rule live to a very old age and they usually succumb before the ravages of age can overtake them. They have an opportunity of enjoying a longer span of life in a zoological park where they are protected and sheltered.

One of the objects of the modern zoological park is to secure normal specimens of different species of animals in sound condition and in good health—to present, as it were, a cross-section of the animal kingdom for the study and enjoyment of its visitors. The very presence of an animal on exhibition should, and generally does, mean that it is a sound and healthy representative of its kind.

Most specimens are obtained from dealers, although adventurous individual collectors or expeditions may capture wild animals in their native habitat and then transport them at their own risk to one of the zoological parks. Some specimens, principally small mammals like monkeys, ocelots, raccoons and opossums are often donated.

Collectors, naturally, endeavor to capture "record" specimens and to bring back large, healthy animals, but as a rule they must take

Entrance to the Hospital is through the pharmacy, where the Veterinarian compounds his drugs and medicines.

what is available. Sometimes they are able to make a choice of such creatures as African antelopes or zebras, since large herds still are to be found.

To a certain extent, then, the process of selection and watchfulness that surrounds every zoological park specimen actually starts with its capture, but after it is caught there is a whole series of hurdles it must take before it is finally ready for exhibition.

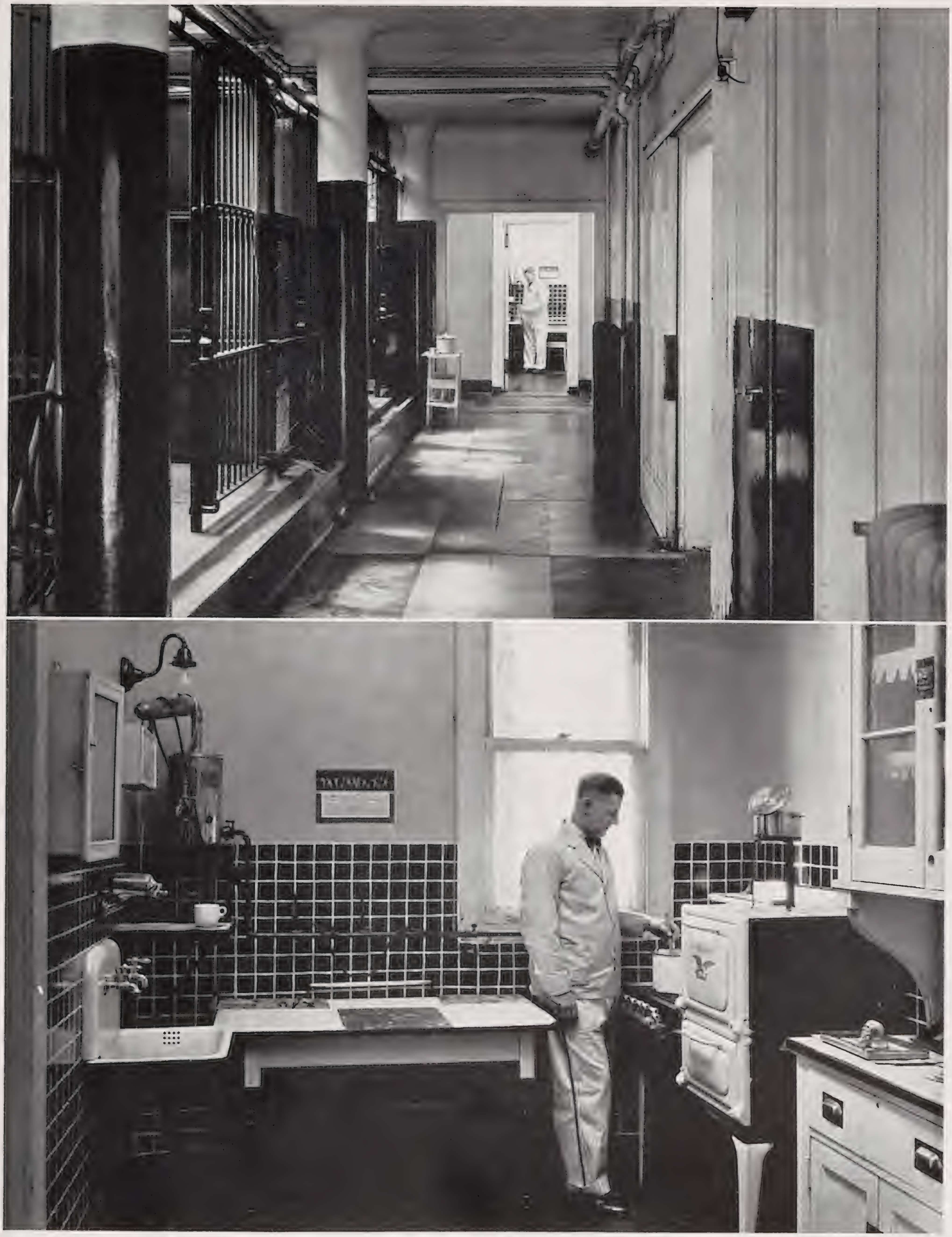
Three governmental agencies stand between the animal and the Park. Two of them, the Bureau of Biological Survey and the Bureau of Animal Industry of the Department of Agriculture, are charged with the duty of protecting our agricultural resources, domesticated livestock and native wild animals from the ravages of imported pests and disease. The third agency that watches over animal importations is the Public Health and Marine Hospital Service, which endeavors to keep out animals which may be carriers of diseases transmissible to man.

Before any wild animal can be brought into this country it is usually necessary that a permit to import be obtained from the Bureau of Biological Survey. This agency, it is true, is not so much concerned with the health of the animal as with its economic status. In other words, the Bureau is a sort of immigration authority to make sure that no animal immigrant may become an economic liability. The reason for this precaution can readily be seen when the classical case of the importation of the apparently harmless rabbit into Australia is recalled. As a result of the favorable conditions there, rabbits multiplied so rapidly that they became a pest and consumed vegetation that was needed to maintain the sheep industry. Another illustration is that of the mongoose in the West Indies. Brought in to exterminate snakes, it now is a real menace to birds and other forms of wild life, thereby upsetting the balance of nature.

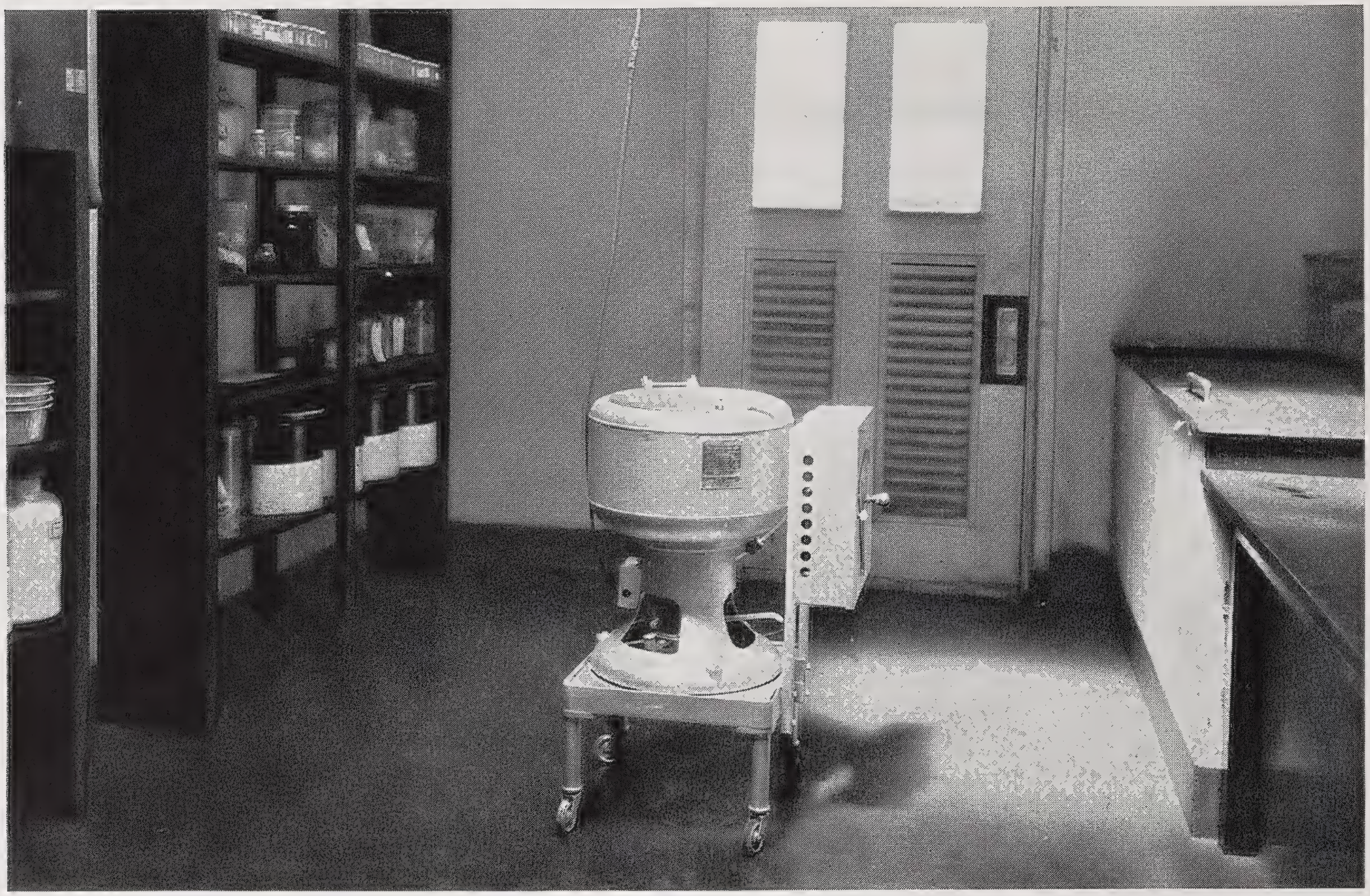
Among the animals which are absolutely forbidden to enter the country is the great Malayan fruit bat. Two or three times within the past six months enthusiastic animal dealers have made attempts to import specimens of that most spectacular of bats, with a wing spread of five feet. In each instance the Federal authorities promptly and firmly ordered them destroyed at the port of entry and sent inspectors to see that the order was executed.

In Malaysia this giant of the genus *Pteropus* feeds upon fruit and eats or damages large quantities during the night. It is therefore a serious potential menace to commercial fruit growers here. Of course, the possibility of such bats escaping from a zoological park and increasing is remote, but the Federal authorities make no exception to their rule.

The veterinarians and inspectors of the Bureau of Animal Industry are constantly on the alert to prevent the entrance of infectious diseases which may be transmitted to the livestock of this country. They are particularly on guard against the introduction of foot and mouth disease, rinderpest and anthrax. Cloven-hoofed animals such as yaks from Tibet, gayals from India, bantings from northern India, Cape buffaloes from South Africa, the antelopes of Africa, the peccaries of South America, the babirusa from the Celebes and a host of others



(Top) Strong cages for the larger animals line one side of the south hall of the Hospital. (Bottom) The kitchen must be kept spotlessly clean, for it is here that special foods are prepared for the sick and the improperly nourished new arrivals.



Research in animal diseases is an extremely important phase of the Veterinarian's work, for autopsies often show how to avoid similar losses in the future. This shows part of the pathological collection.

cannot be imported except under special permit from the Bureau of Animal Industry, and then only after they have been carefully examined, their blood tested and shipment made under stringent sanitary conditions. Zebras, kiangs, wild asses and other members of the horse tribe must also be examined in quarantine and their blood tested. They can only be admitted after they have been proved free from infectious disease.

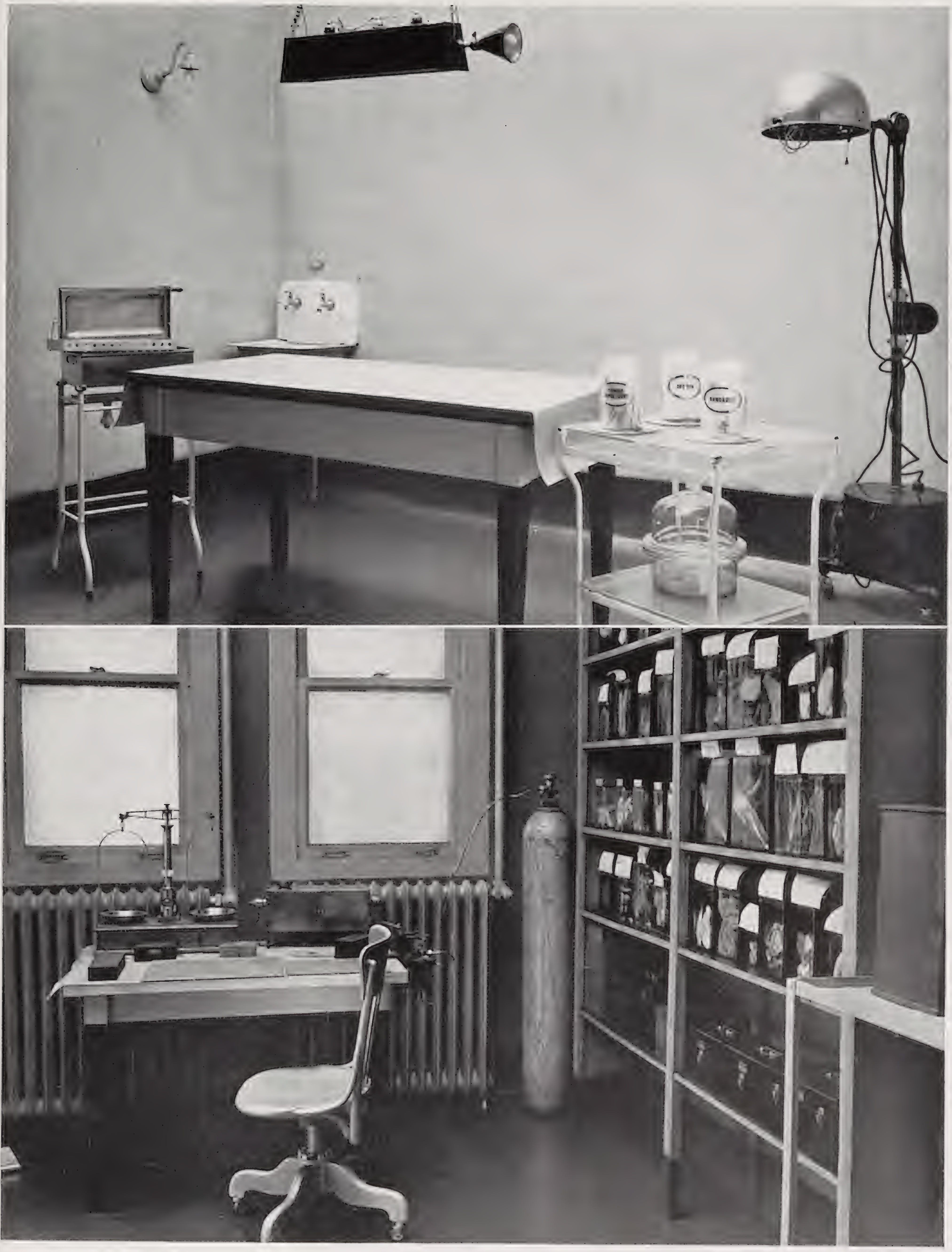
The maintenance of a varied collection of wild animals in any zoological park requires the services of specialists in different fields of zoology. The veterinarian cooperates with these specialists in maintaining the collections in a state of normal health.

The veterinarian is concerned with the quarantine of new animals, sanitation of their living quarters, study of their dietary requirements, the prevention of infectious diseases, and the medical or surgical care of sick or injured specimens.

Quarantine and sanitation are the keystones in the prevention of infectious diseases. Even though newcomers to the Park have been acceptable to the governmental agencies, they may still be required to remain in the quarantine quarters in the Park's Hospital in order to study their individual requirements as to diet and special care. As a general rule, carnivores and rodents and other small mammals are quarantined in the Hospital for a week to ten days to prevent the possible introduction of distemper or other diseases of small animals.

One of the diseases we must constantly guard against is distemper of dogs. It is caused by a filterable virus which may affect and prove fatal to some carnivores such as wolves, foxes and wild dogs. This is one reason why dogs are not allowed in the Park, for it is possible that some of them may be carriers of distemper.

Contagious infectious enteritis of cats, the so-called "cat distemper," a disease which may affect pumas, ocelots, civets and other members



(Top) The operating room, flooded with light, stands ready at all times for the surgical emergencies that are bound to arise. Fortunately, they are not frequent. (Bottom) Studies in animal pathology are carried on in the diagnosis laboratory.

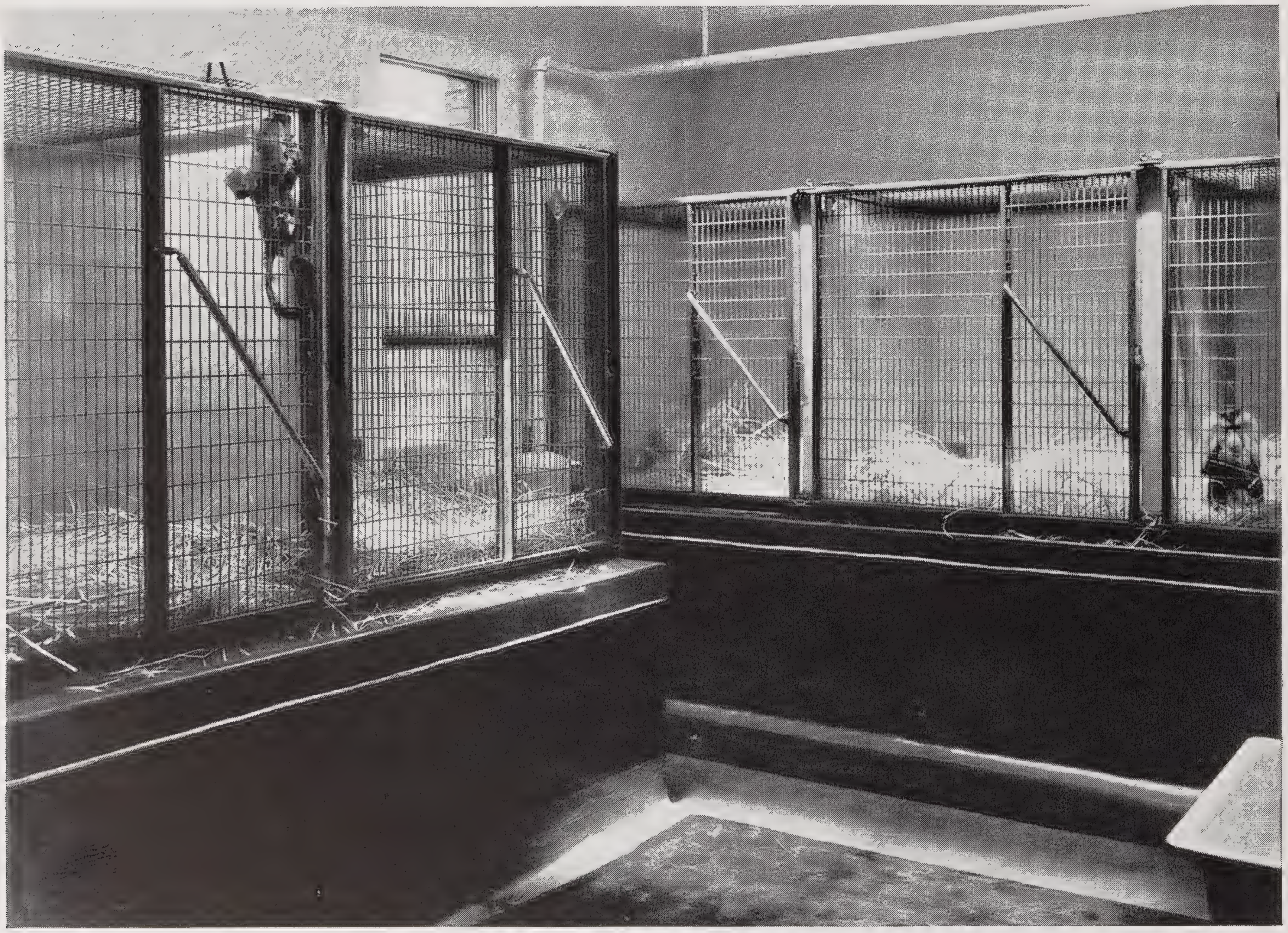
of the cat family, is another scourge that must be prevented. There are a number of contagious and infectious diseases which may be fatal to rodents. The rabbit is a rodent-like animal and some diseases which affect it may prove fatal to other rodents. After symptoms appear, it is necessary to make tests in order to arrive at a correct diagnosis. As an illustration, a symptom present in rabbits such as congested eyes with a nasal discharge is commonly called "snuffles" by the layman. This symptom may be present in a number of infectious diseases of rabbits. Diseases of this kind may be transmissible from one kind of rodent to another and are caused by bacteria, protozoa or filterable viruses.

A number of contagious respiratory or intestinal diseases which affect birds must also be constantly guarded against by keeping the new birds under observation in quarantine.

Absolute physical cleanliness of animals and their corrals, pens and cages is an important phase of sanitation. By keeping the quarters clean and disposing of waste regularly, potential centers of infection are eliminated, and the incidence of infectious disease and parasites is reduced to a minimum. After thorough cleaning, effective disinfection is carried out.

The importance of a well-balanced diet is illustrated in the case of two Tibetan bears which were captured in the highlands of Tibet and brought overland through western China to Shanghai where they were kept in a local zoological garden. During their journey they were fed largely on boiled rice and some diluted condensed milk. At Shanghai they were shipped on a tramp steamer to New York by way of the Panama Canal.

When they arrived in New York they were passed by officials of the United State Biologi-



Light, warm and comfortable cages for the smaller animals are provided in a large and airy room that can be closed off from the rest of the Hospital and maintained in perfect quietness—except for the noise of the patients themselves!

cal Survey. As a result of the rough journey over sea and a defective diet, they were found to be suffering from malnutrition. They were weak on their legs and unable to get about, and their white conjunctivae and eyes indicated that they were anemic. Their hair coats were dry and coarse. They weighed twenty-seven and twenty-five pounds respectively. They were very young and their large heads, slightly bowed legs and general weakness indicated that they were suffering from rickets.

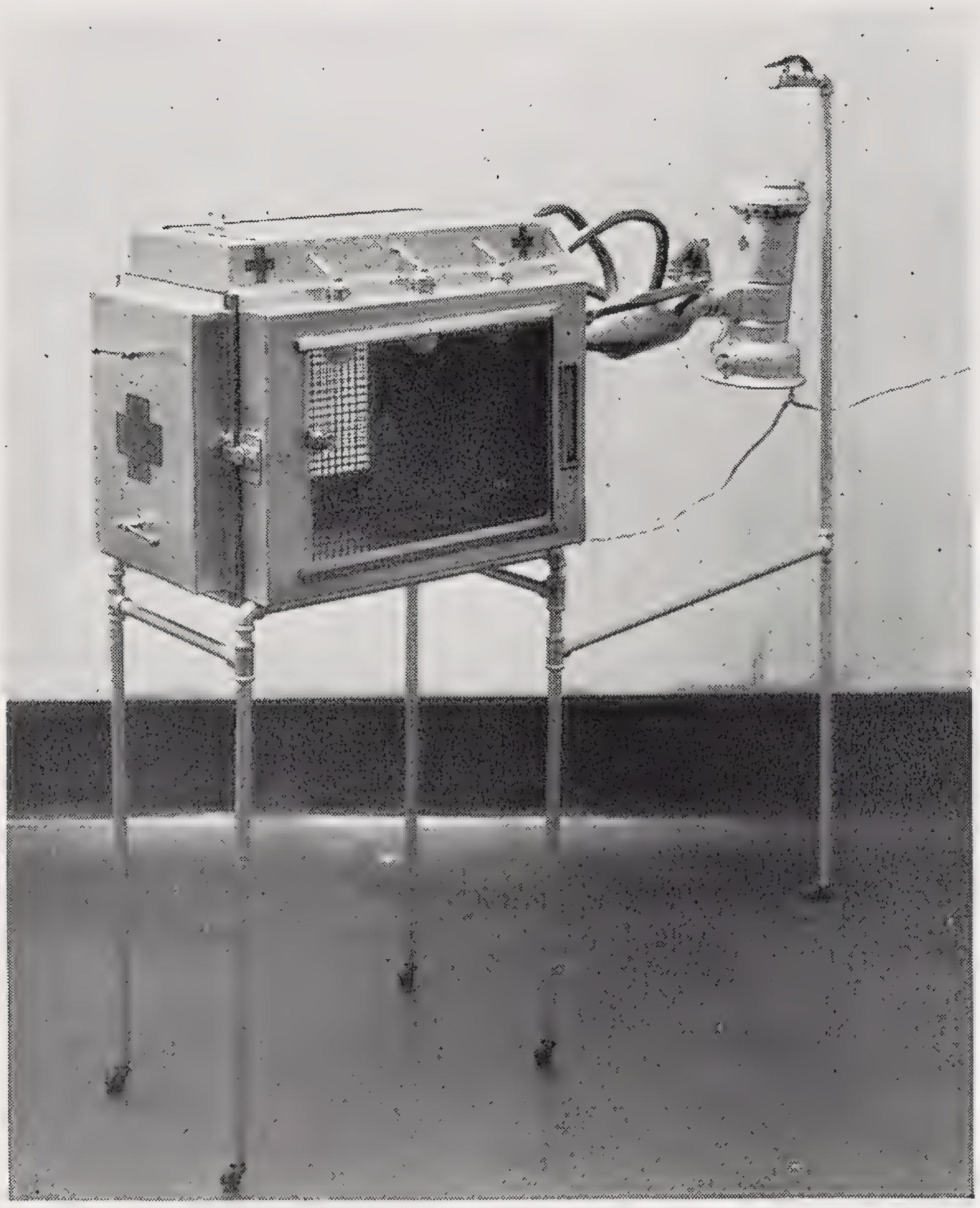
They were placed in a warm, dry, comfortable cage at the Hospital and put on an adequate diet. Each morning they were given a large pan of diluted, irradiated, dried milk with four to six eggs well beaten in. Soon they began to look for their milk and eggs. Being fed twice a day, their second meal consisted of a pan of stewed beef, carrots, potatoes, bones and codliver oil.

During the first three weeks their improvement was rather slow. They were still weak on their legs but from the fourth week on they made steady gains and at the end of two months they began to show definite signs of improvement. Their eyes became clear and bright, gums pink, tongues clean, appetites ravenous. Their hair coats became smooth and soft—all signs of returning health. They also began to romp around the cage and take an interest in life by climbing up the sides of the cage. At the end of six months they weighed sixty pounds apiece.

They are now in good health and on exhibition and give promise of continuing to remain at the Park for some years to come.

After having passed through the period of observation and quarantine, the newcomer to the Park is finally placed on exhibition in one of the animal houses or else in one of the outdoor

This is not an emergency case—just one of the periodical examinations of the health of Buddy, the intelligent young chimpanzee. Buddy submits with perfect docility to an inspection of his teeth by the Veterinarian.



This ingenious apparatus is a vaporizer, built by John Merritts, the Hospital attendant, for the treatment of colds.

ranges if it be a member of the horse, cattle or deer family. Most of the deer, yaks, buffalo, tahrs and aoudads have been born and reared in the Park and live out of doors the year round in an approximately natural environment. Delicate and tropical species are housed in heated buildings during cold weather.

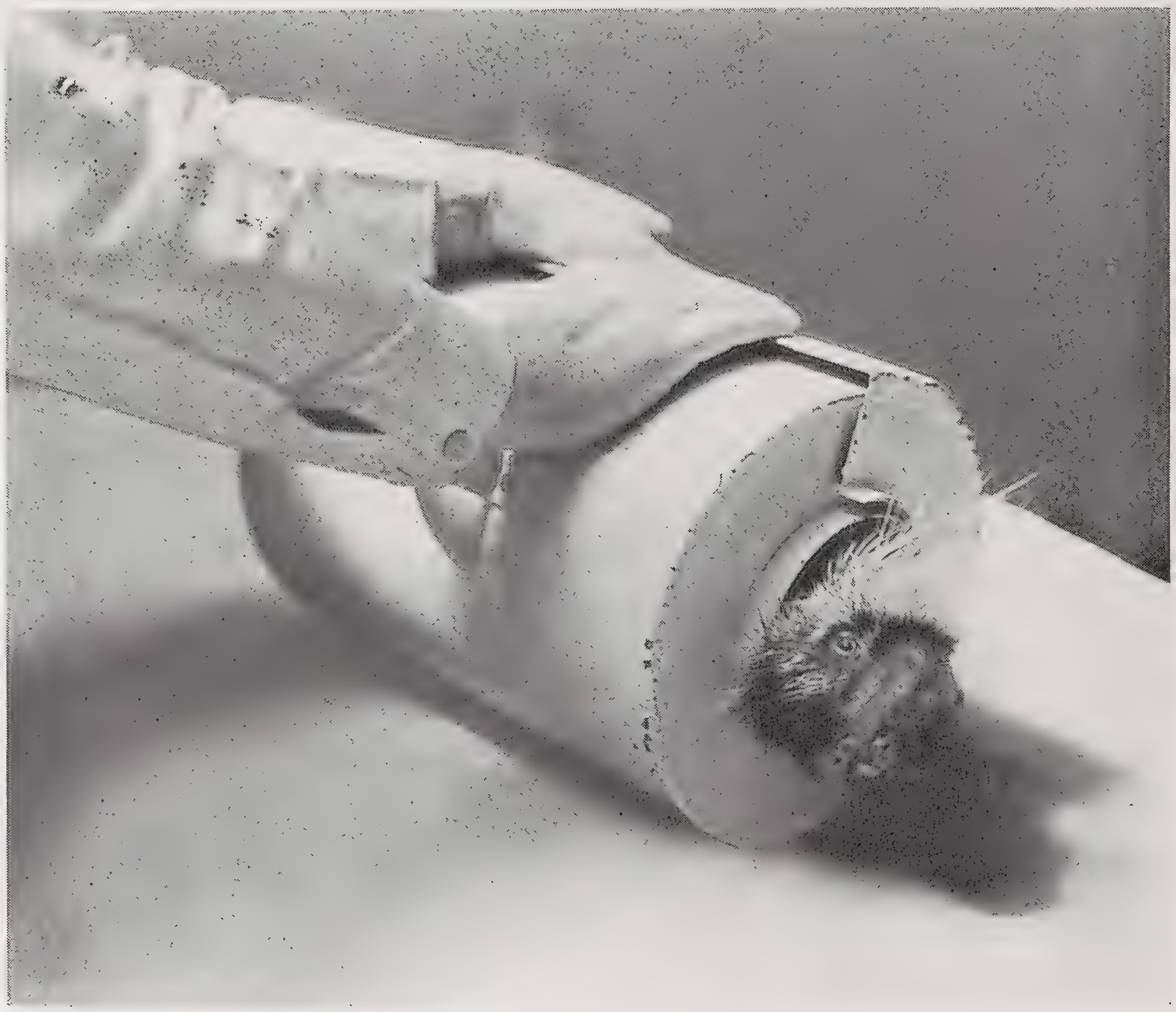
The keepers are sympathetic men who attend to the daily requirements of their charges as to feed, clean cages and observation. If any specimen shows signs of illness, the veterinarian is notified.

Minor injuries resulting from fights among the animals and digestive disturbances caused by overfeeding by indulgent visitors at times cause considerable discomfort to some of the animals and frequently lead to more serious illnesses. When they get old they develop illnesses incidental to old age. Each specimen must receive constant individual care and treatment in order that the collection as a whole may be maintained in a state of good health.

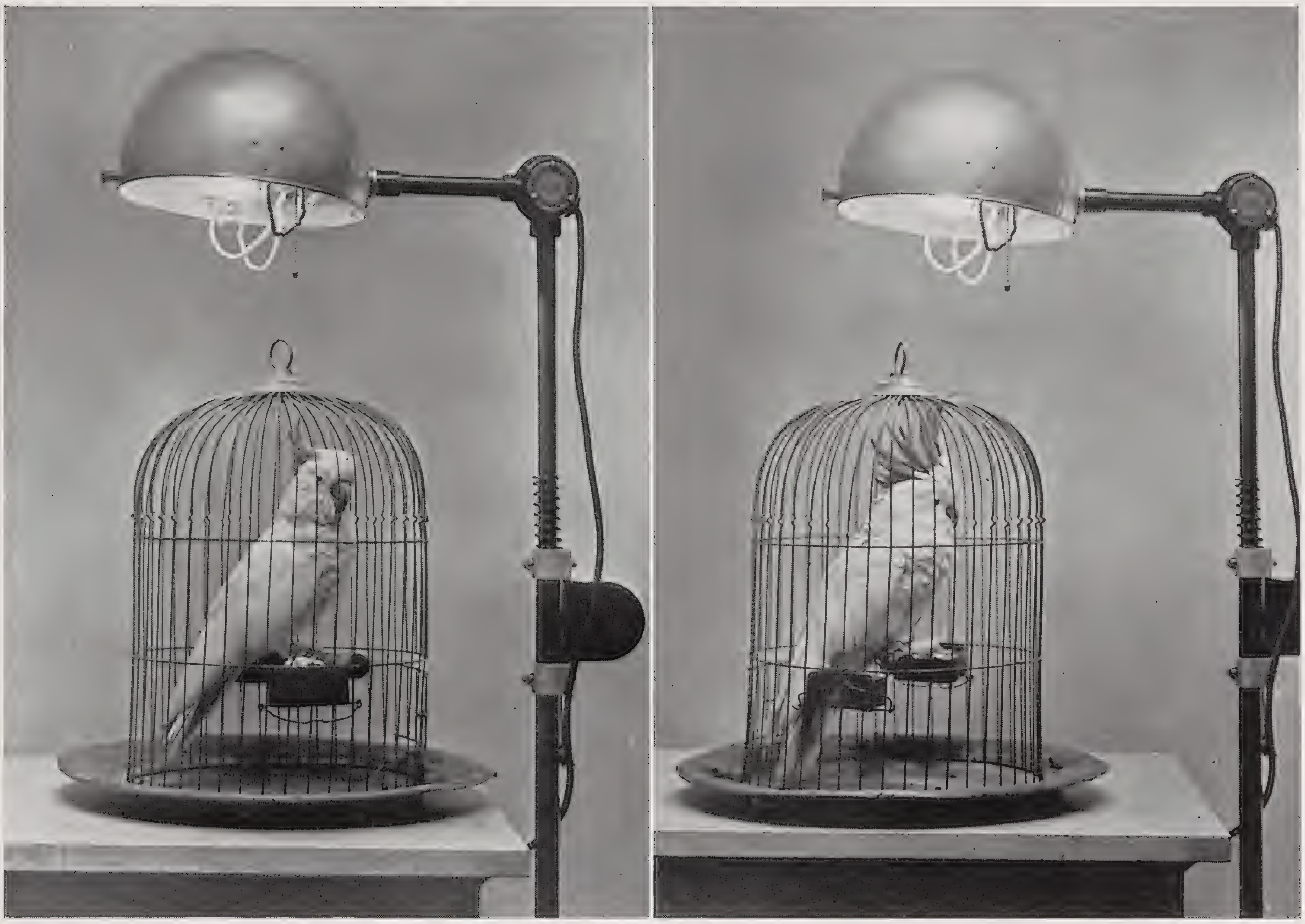
Facilities are provided for the treatment of minor illnesses or injuries in each of the animal buildings. Animals suffering from serious injury, however, are taken to the Hospital where they may receive adequate medical or surgical treatment and nursing.

The Hospital is centrally located in a secluded part of the Park in order to provide a quiet place where the animal patient will not be disturbed. As in the case of sick human beings, a calm, quiet atmosphere is more conducive to the sense of well being in the sick than an everyday, noisy place.

The Hospital building is a simple one-story yellow-brown brick structure facing toward the south to get the full benefit of sunlight. It has a frontage of about fifty feet, and is provided with six large sanitary compartment

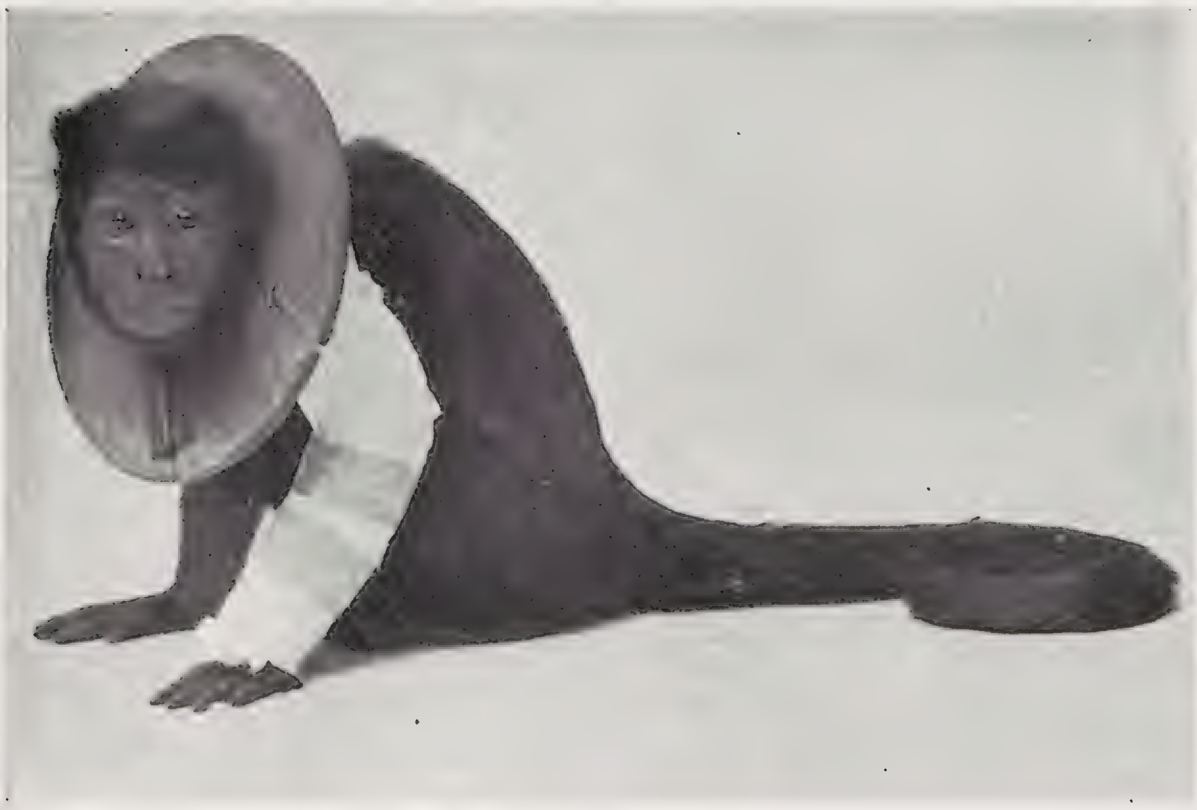


The handling of a sick porcupine was always a problem until this hinged tin tube was constructed, and now it can be examined without danger from its sharp quills.



Ultra-violet lamps that give the effect of natural sunlight are useful in dull winter weather. A sulphur-crested cockatoo came to the Hospital ailing and drooping, but in a few minutes its crest showed its reaction to the heat and warmth.

cages for large animals. There are two entrances on the southern side: one to a long hall running in a north and south direction, and one to an office and waiting room.

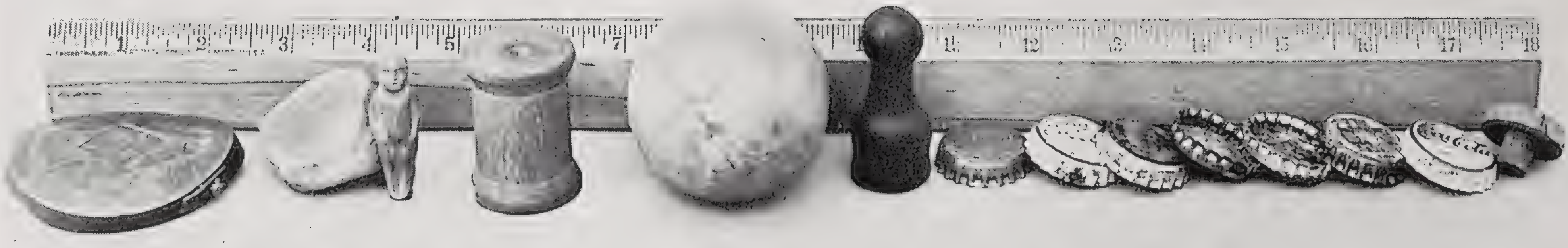


The problem of how to prevent a monkey with a broken arm from picking at the bandages with his teeth was solved by a light wooden collar.

Entering the building through the waiting room one finds a well equipped kitchen. Along the right side of the hall are three large rooms. The first is the operating room, provided with a large skylight, the second is a diagnosis laboratory and the third a mortuary. Along the left side of the hall is located the small animal section provided with nine sanitary cages, and the office of the veterinarian.

Another hall runs in an east and west direction behind the cages for large animals and opens into a large workroom and into the section of special cages for small animals.

The compact kitchen-pharmacy is provided with a modern gas range, cup-

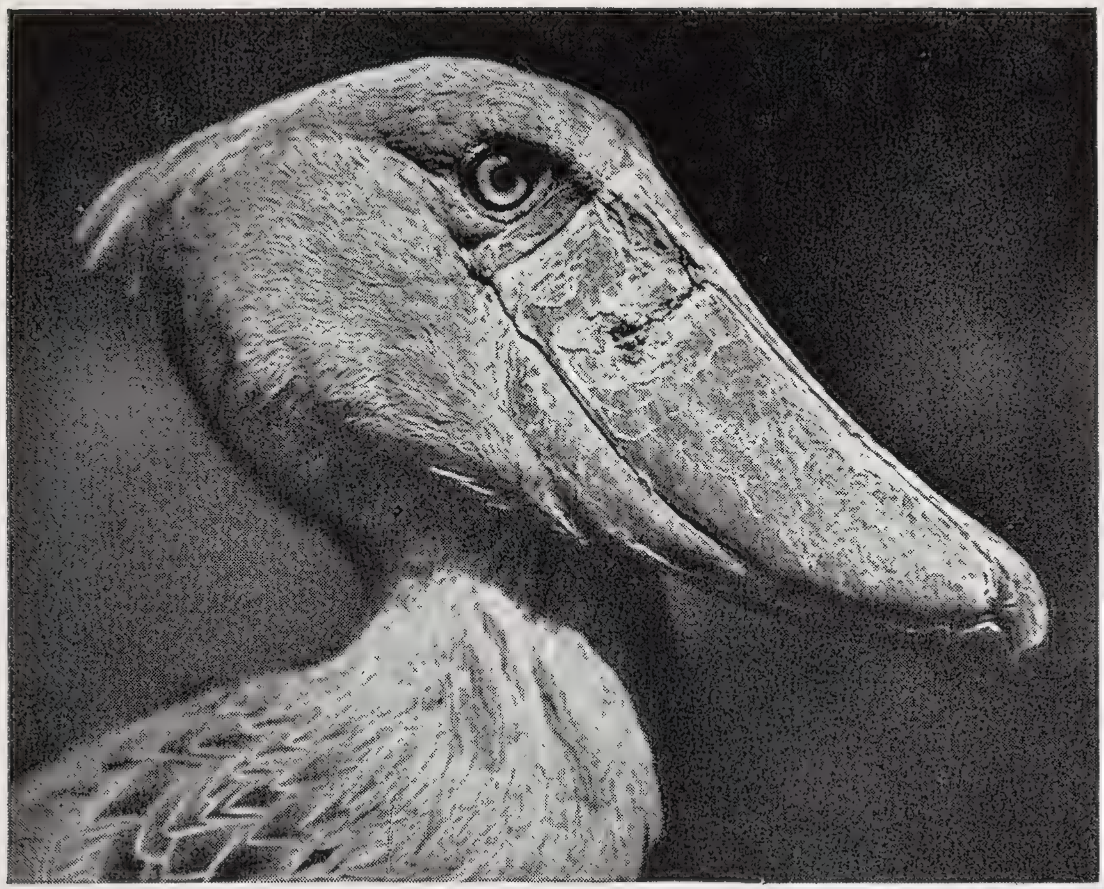


All these objects were found in the stomach of a cassowary that died from an impaction of its digestive tract. Thoughtless visitors who throw foreign objects to the animals cause the death of several each year, particularly birds and sea lions.

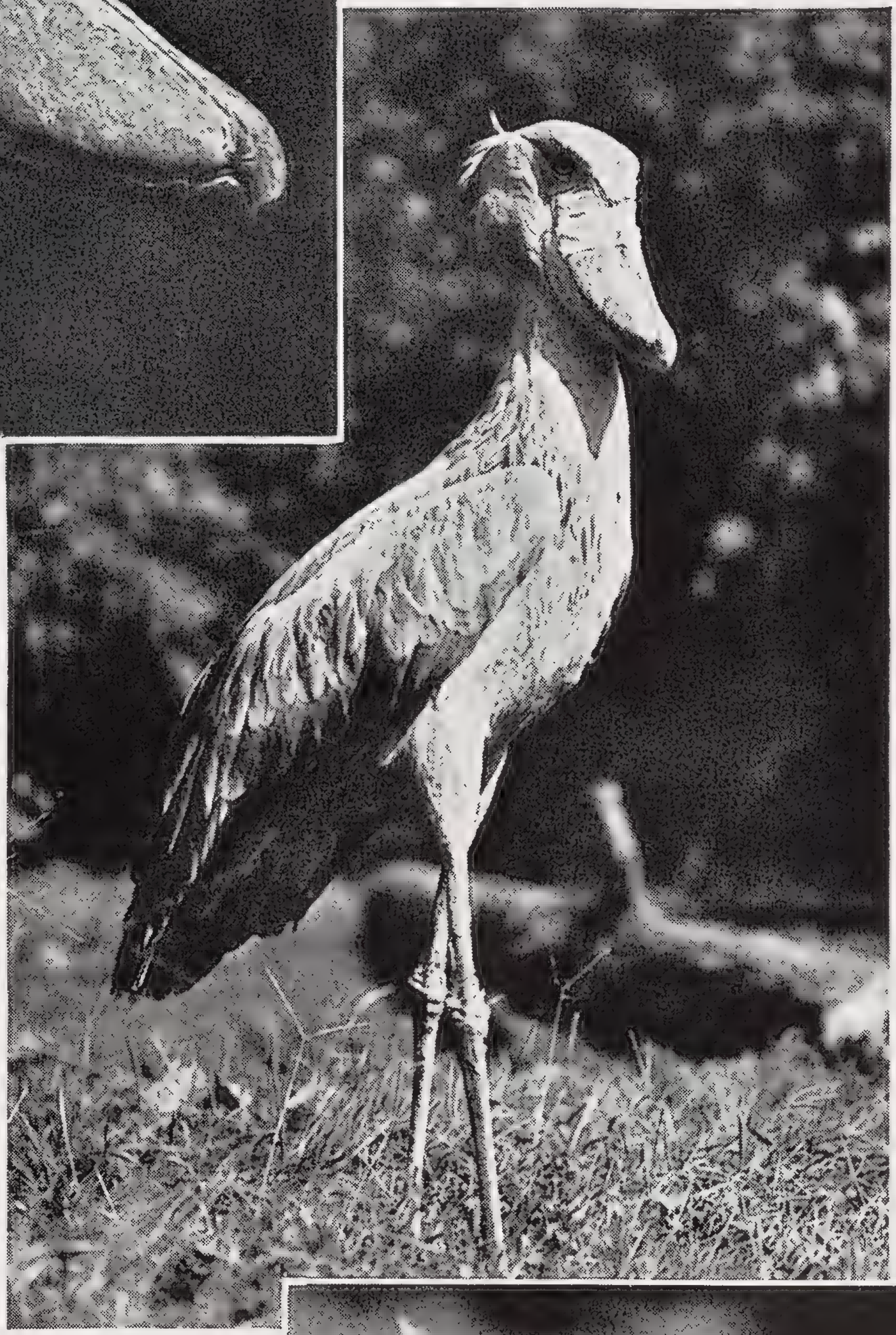
board and several medicine cabinets containing important and useful supplies of drugs and surgical equipment.

The floors and walls of the Hospital are constructed of smooth finish concrete and cement so that they are easily cleaned and kept sanitary. The cages are separate sanitary units of cement and iron construction. The water sup-

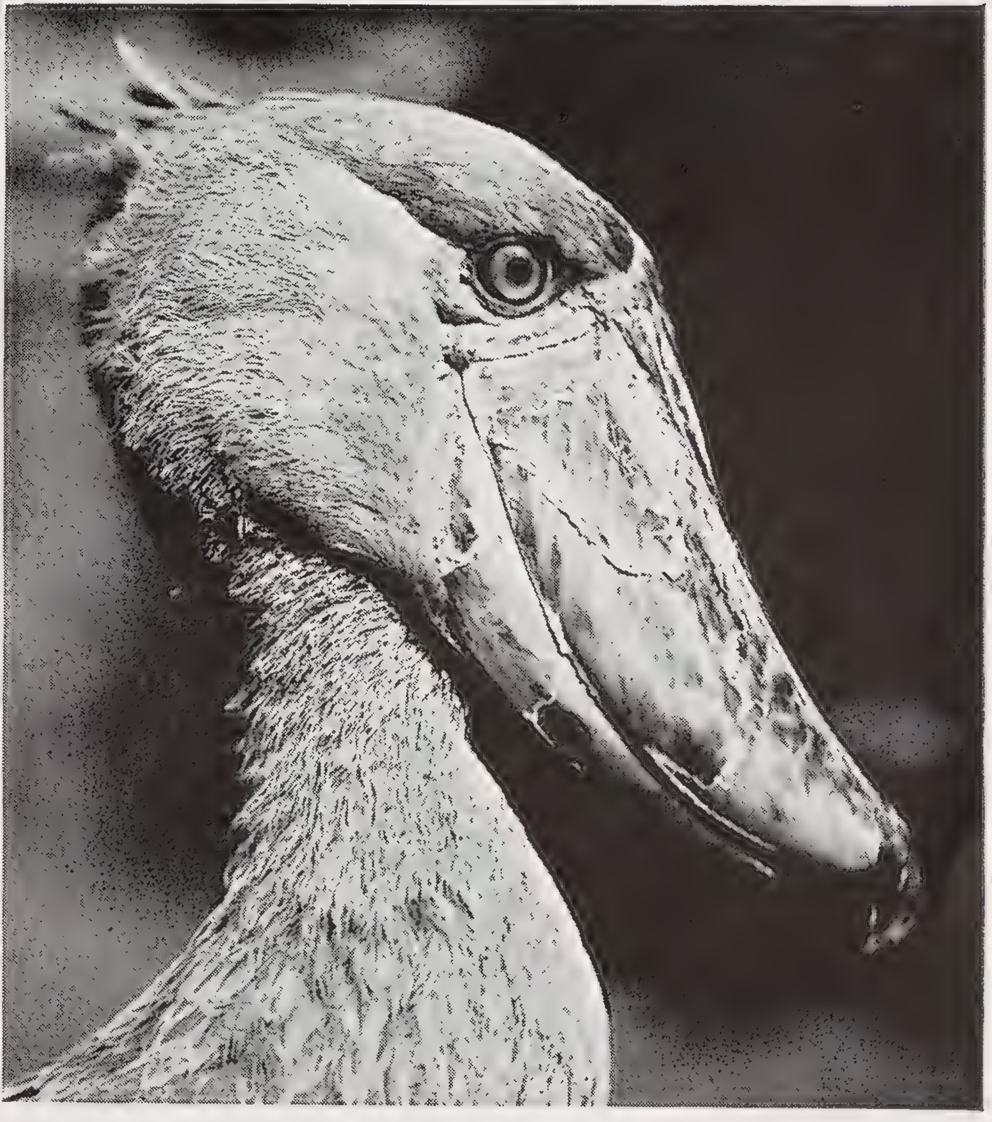
The treatment of a sea lion with a cold may seem difficult, but it is really simple. A rope loop enables the keeper to open the mouth, and then the inflamed throat can be swabbed with a mild antiseptic solution.



(Above) A blow from a stone injured the bill of Jimmy, the rare shoe-bill stork, and rendered him susceptible to a serious infection of the head and throat.



(Below) For months Jimmy was compelled to wear a bandage on his bill while it was under treatment. (Bottom) The bill finally healed perfectly.



ply and drainage of this building are adequate and satisfactory.

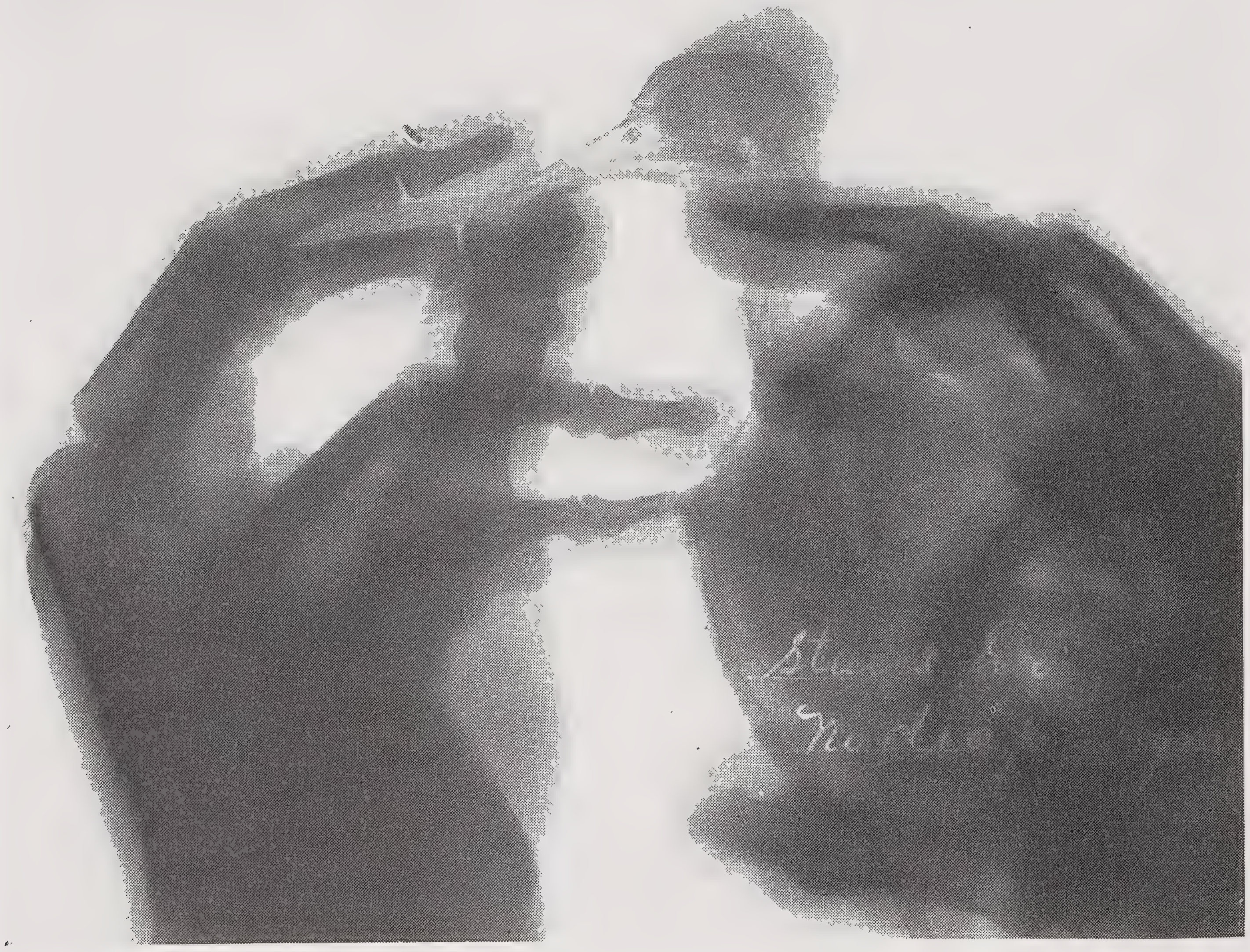
The kitchen plays an important part in the administration of the Hospital, for it is there that a wide variety of diets is prepared during the course of the year for a heterogeneous group of animal patients among which are vegetarians, meat eaters, fruit eaters and those which live on a mixed diet.

Among the staple foodstuffs used are irradiated dried milk, eggs, apples, oranges, bananas, potatoes, carrots, lettuce, cabbage, beef, mutton and other meat if needed. Food for herbivorous animals is obtained from the forage supply—timothy, red top, clover, alfalfa hay, oats, wheat, bran, corn, salt and calcium and phosphorus preparations as well as a good supply of cod-liver oil. All the food must be clean, sanitary and wholesome and fresh, for animals are also subject to illness from spoiled or contaminated food.

The Hospital is provided with an abundance of sunlight and fresh air. The circulation of air is greatly facilitated by means of exhaust fans located in different parts of the building. These fans are electrically driven and remove air by means of special ducts, thereby providing an efficient system of ventilation.

With its smooth, sanitary floor, walls and ceiling and a large overhead skylight which lets in a flood of sunlight, the operating room furnished with essential but not elaborate equipment is perhaps one of the most interesting rooms of the Hospital. It stands ready at a moment's notice for surgical service for animals. While surgical cases requiring the use of the Hospital are not frequent, they usually occur at unexpected times.

Four years ago a rare female ibex, a goat-like creature which in its native state plays among the rocks on mountain sides, became a surgical case. One day while feeling frisky and jumping around its corral it tried to jump over a fence and in so doing it accidentally broke the bones of one of its hind legs. It was immediately removed to the Hospital and anesthetized. Its broken bones were set and immobilized in a yucca board cast. A few months later the fracture healed and the recovered patient was again placed on exhibition.



The X-ray has often proved useful in the diagnosis of animal diseases. In this case, it revealed the nature of the abnormal swelling on a dove's skull.

One is frequently asked, "How do you handle your cases?" A brief reply would be as follows: There are several methods of restraint that may be used with wild animals. The method of restraint must be sure and safe for both the animal and the attendants. Nets, special cages with movable false sides inside the cage, crates and loops are among the contrivances commonly used. If an animal is quite sick, practically no force is required to examine and treat it. Many sick animals seem to realize that they are being treated and cooperate with the doctor; others are not so responsive.

In major surgical cases the use of general anesthesia is of utmost importance from a humane and medical point of view. Fortunately a wide variety of anesthetics is available. Ether, chloroform, novocain and more recently a series of preparations having barbituric acid as their base have been used quite successfully in different species of animals.

The method of administering these barbituric acid compounds is simple and efficient. The proposed dosage is determined after considering the weight of the animal and its temperament. A solution is prepared and injected by hypodermic syringe, either subcutaneously or intraperitoneally. After a wait of fifteen to thirty minutes the animal is usually under complete anesthesia and the surgeon can carry out his operation satisfactorily.

Common colds occur at times among the primates and monkeys and seem to be transmissible to them from human beings, for when there is an epidemic of colds among people we frequently find that the monkeys also develop colds.

The treatment of mild cases of colds is relatively simple. The animal is kept warm and comfortable, given orange juice and cough syrups, and its chest is rubbed with camphor oil or other local medicaments. In order to relieve congested noses and in cases of mild bronchitis, inhalations of warm vapors of eucalyptus oil are prescribed. Recently a very effective and satisfactory apparatus for the administration of these vapors was designed and built by John Merritts, the Hospital attendant. This apparatus consists of two parts, one a vaporizer provided with an electric fan and a preheating resistance coil. Here the eucalyptus vapors are generated and then they are forced through copper tubes into a glass-covered inhalation chamber, the second part of the apparatus. When an animal is placed in this chamber it receives the full benefit of the vapor.

The diagnosis laboratory is equipped with a bacteriological incubator, microtome for sectioning tissues, microscope and other essential equipment to examine secretions and specimens. This apparatus aids materially in making a diagnosis and in prescribing proper treatment.

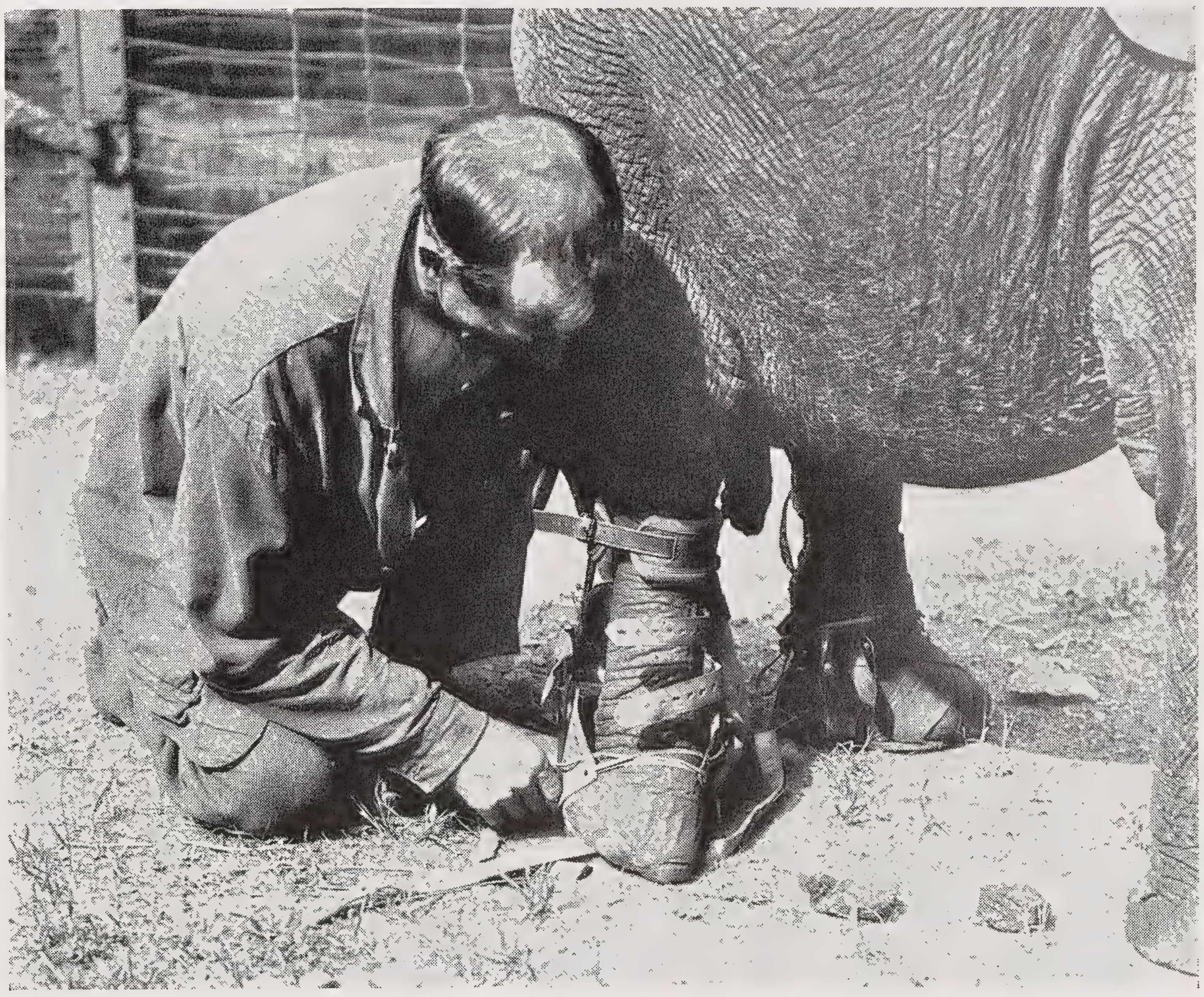
The Hospital is also equipped with an ultraviolet lamp which provides artificial sunlight on winter days. A number of "daylight" lamps form a part of the equipment of the Primate House for use during the winter months in providing artificial sunlight.

After an animal has been placed on exhibition it usually thrives and lives its normal span of life, giving joy and pleasure to the visitors. Since the keepers know how to and do properly feed and care for their charges, no digestive disturbances due to regular feeding occur. During the spring, summer and fall months digestive disturbances occur more often when the attendance is heaviest. Well-meaning visitors may overfeed some of the smaller mammals. It is not a serious thing for a small mammal to eat a small bit of popcorn or other tidbit, but when one considers that thousands of visitors visit the Park on a single day, the amount of material which may be fed is very great and it is surprising that more of the animals are not taken ill with acute indigestion. These cases require prompt attention and are sometimes fatal to the innocent animal victims.

During the course of the year several small mammals die and on autopsy it is found that they have been fed on metal objects, foreign bodies of various kinds, and small pieces of rubber. In one case part of the covering of an umbrella was found lodged in the stomach and intestine of an ocelot. While such cases are not very frequent, nevertheless they do occur.

Sea-lions are active and agile and quite intelligent. They are a source of amusement as they gracefully swim and glide through the clear water of their pool. The quick, almost lightning-like speed with which they coordinate eye and muscle in catching fish that are thrown to them at feeding time is amazing. Their barking and antics attract hundreds of visitors on crowded days.

Ignorant but well meaning individuals sometimes throw indigestible objects to the sea-lions and thereby cause unnecessary suffering and loss of these beautiful animals. Their stomachs are not large and their intestines are very nar-



The ingenuity of Veterinarian and keepers must be equal to any emergency—such as providing a shoe for the injured foot of a pigmy elephant, as in this case.

row so that only well digested food can pass along the intestinal route. It is obvious that if indigestible objects are fed they become a serious menace to the well-being and health of the sea-lion. Two or three sea-lions are sacrificed each year to foreign bodies. Such things as handkerchiefs, (twenty-six in one stomach), and large stones the size of stove coal, have been found in the stomach of a sea-lion. In one case four tennis balls and several smaller metallic objects were found. While these objects can be swallowed, it is impossible to digest them and they become a source of irritation, causing a severe and fatal gastritis.

The ostrich is popularly credited with being able to eat and digest almost anything. A Darwin cassowary, a valuable and rare ostrich-like bird, was lost as the result of an impaction of the digestive tract. It was found that its stomach contained seven metallic tops of pop bottles, a metal doll two inches high, a large wooden spool two inches long and one inch wide, and a circular, gold-plated brass top of a vanity case two and a half inches in diameter.

The rare whale-headed or shoe-bill stork (*Balaeniceps rex*) is a dignified bird from the east with a large bill. One day it was discovered that his bill had been injured by a blow from a stone. The injury resulted in a large wound which exposed the delicate interior of the bill. In birds of this kind a wound of this character is very serious because spores of moulds which are constantly present may easily gain access to this area, grow, and develop into deadly moulds which fill the cavity, spread to the lungs and kill the specimen.

The keeper fortunately notified the veterinarian promptly and treatment was instituted by raising the injured ends of the bill and treating surgically. It took one and one-half years for this wound to heal and now Jimmy the Whale-headed Stork can be seen in all his dignity.

Sea-lions may contract colds and suffer from sneezes and pharyngitis. Mild antiseptic solutions are used to swab out the mouth and throat. While sick they are not able to get around and seem to appreciate efforts made to relieve their symptoms. The inflamed throat of a sea-lion can be reached and swabbed out with a mild antiseptic solution by opening its mouth with a rope loop.

The onager is one of the wild asses of western India and the kiang is a closely related form from Tibet. Their offspring is called a "kianager," and one was born in the Park. In the usual course of events the mother would have nursed her baby foal. For some unknown reason this mother refused to nurse her offspring. Different schemes were tried to induce her to do so and it was only when she was placed in a restraining cage that she would permit her baby to suckle.

Many captive wild animals in zoological parks become accustomed to their permanent quarters and frequently live to a ripe old age —perhaps beyond the allotted span under natural conditions. A number of such animals finally succumb to the infirmities of age.

All animals that die are examined and their remains sent to the American Museum of Natural History for taxonomic and zoological study. Notes are made of the pathological findings. Anatomical material is frequently sent to the various scientific organizations in the city and at times to institutions in other parts of the country. These post-mortem examinations throw light on the probable causes of death and thus help in formulating methods of treatment.

Patriarchs in the Zoological Park

A Census of Some of the Older Inhabitants

William Bridges
Curator of Publications

OLD Charlie, the Florida Alligator, was forty-three recorded years old when he rolled over in his tank and died a year ago this spring, and when he succumbed to the diseases incident to advanced age and a turbulent life the Zoological Park lost its oldest specimen.

Did Charlie set a record for longevity? How long can an alligator live in a state of nature, or under the most favorable conditions of captivity? Nobody knows for certain, any more than anybody knows with real exactness the life span of any but a very, very few species—*Homo sapiens* certainly, and with less definiteness possibly eight or nine others.

Our knowledge of the probable duration of life of wild animals in captivity might be considerably increased if every zoological park kept detailed, specific records of individuals on exhibition and if someone were to coordinate all the recorded facts. Unfortunately even the best of records are likely to be incomplete in some important particular and in a majority of cases even the approximate date of an animal's birth must be a matter of conjecture.

Even so, the duration in captivity is an index to longevity and viability and valuable compilations have been made from the data of the Zoological Society of London and many other institutions—sufficient for Major S.S. Flower to be able to say that "There are a few species of which the main facts are known, as man, lion, cat, dog, horse, oxen, goat, giraffe, hippopotamus and kangaroo."[1]

In 1911 Dr. P. Chalmers Mitchell, Secretary to the Zoological Society of London, drew up viability tables for some 20,000 mammals and birds that had lived and died in the London Zoological Garden between 1870 and 1902. His paper, "On Longevity and Relative Viability in Mammals and Birds,"[2] continues to be an important source of information about the life span of animals in Zoological gardens, although since then Major Flower has gathered later and more comprehensive data.[3]

Without attempting to present any data drawn from the records of animals that have died in the Park, this article submits the records of twelve mammals, six reptiles and six birds now living in the Park and which have been on exhibition for twenty or more years.

On this date, June 1, thirteen specimens have been in captivity for more than twenty-five years and eleven others have been under observation in the Park between twenty and twenty-five years. In several instances, of course, the actual age of the animal is greater, because it was well on the way to maturity when it was acquired. The extreme instance is probably that of Alice, the Indian elephant. Alice was born in 1893 but did not enter the Park's collection until September 3, 1908, when she was already fifteen years old.

From the standpoint of actual age, therefore, Alice must be considered the principal patriarch of the Park and since elephants have a relatively great longevity she will no doubt be able to maintain her position and eventually to succeed to the rank now held by a Carolina alligator which has been in the reptile collection since it hatched from the egg on October 20, 1900, and therefore holds the record for exhibition of 34 years and 7 months.

Among the Park's mammals, the dean so far as duration of exhibition is concerned is the bald-faced grizzly bear known as Baldy. Acquired as a cub one year old, Baldy has led a peaceful life in the bear dens for 31 years and 2 months, and seems likely to continue to exist for some years to come.

The twelve mammals of greatest duration in the Park—all of them being still alive—may be set down as follows:

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[1] Major S.S. Flower: Contribution to Our Knowledge of the Duration of Life in Vertebrate Animals.—Mammals. *Proceedings of the Zoological Society of London,* Part 1, April, 1931, p. 230.

[2] *Proceedings of the Zoological Society of London,* 1911. Pp. 425-548.

[3] *Proceedings of the Zoological Society of London,* 1925. Fishes, p. 247; Batrachians, p. 269; Reptiles, p. 911; Birds, p. 1365. 1931, Mammals, p. 145.

(Top) The oldest animal in the Zoological Park, in point of years on exhibition, is a Carolina alligator (in the foreground) that is 34 years and 7 months old. (Bottom) Alice, the big Indian elephant, is actually older, however. She is 42.

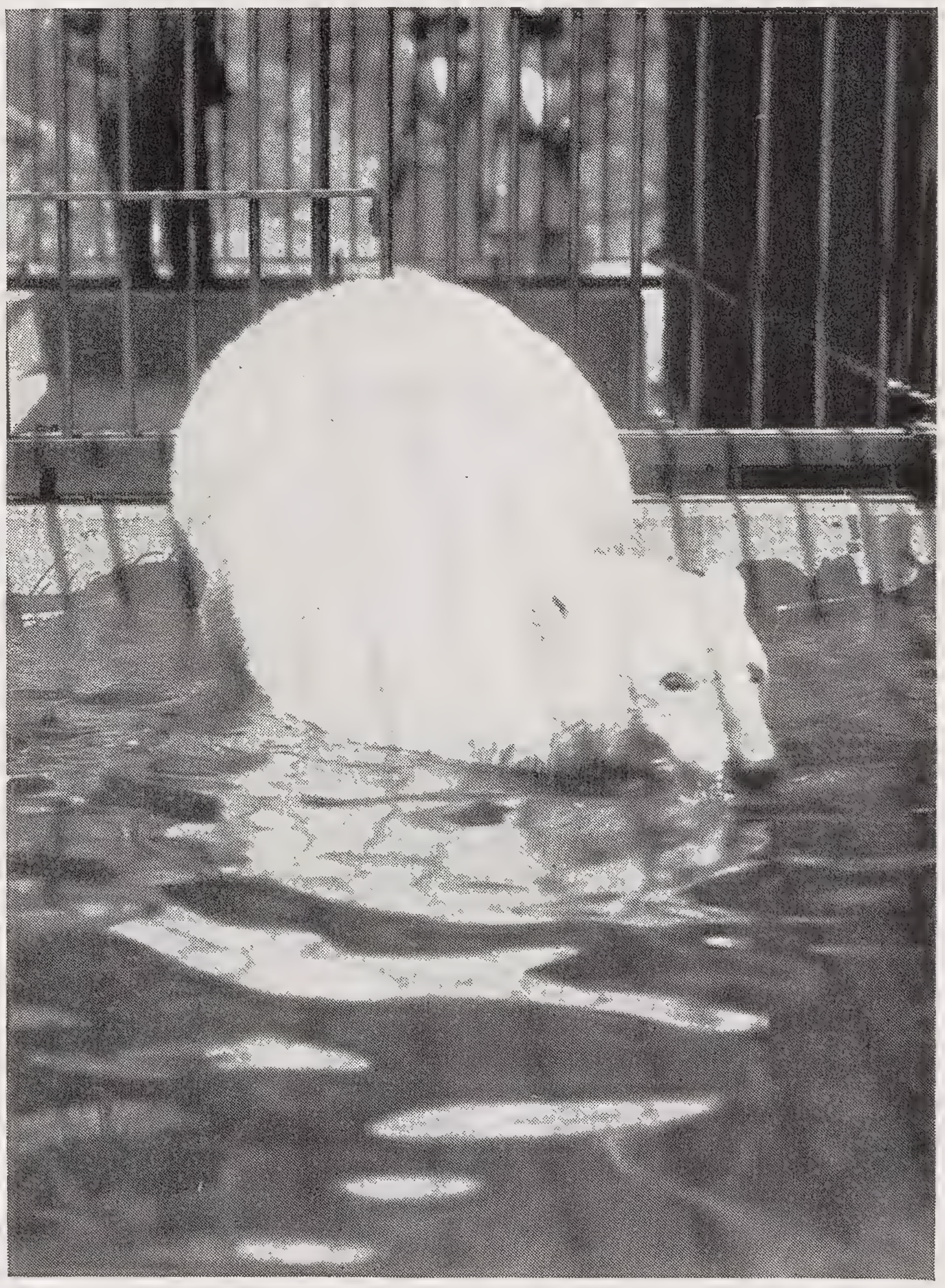
	BORN	ACQUIRED	KNOWN AGE	IN THE ZOOLOGICAL PARK (still alive)	MAXIMUM AGE IN FLOWER'S RECORDS (1931)
1. ♀ Bald-faced Grizzly (*Ursus horribilis*)	1903	April 1, 1904	32 yrs.	31 yrs., 2 mo.	30 yrs. (Cologne Z. G.)
2. ♂ Hippopotamus (*Hippopotamus amphibius*)	July 13, 1903	July 14, 1906	31 yrs, 10 mo.	28 yrs., 10 mo.	41 yrs., 7 mo. (Jardin des Plantes, Paris)
3. ♂ Kadiak Brown Bear (*U. middendorffi*)	Feb., 1907	Sept. 12, 1907	28 yrs., 3 mo.	27 yrs., 8 mo.	23 yrs., 8 mo., (National Z. P., Washington)
4. ♀ Kadiak Brown Bear (*U. middendorffi*)	Feb., 1907	Sept. 12, 1907	28 yrs., 3 mo.	27 yrs., 8 mo.	23 yrs., 8 mo., (National Z. P., Washington)
5. ♀ Indian Elephant (*Elephas maximus*)	1893	Sept. 3, 1908	42 yrs.	26 yrs., 8 mo.	♀ 47 years., 1 mo. (Dresden Z. G.)
6. ♂ Alaska Brown Bear (*U. innuitus*)	Feb., 1907	Feb. 3, 1909	28 yrs., 3 mo.	26 yrs., 3 mo.	
7. ♀ Polar Bear (*Thalarctos maritimus*)		Sept. 10, 1910		24 yrs., 8 mo.	♀ 33 yrs., 4 mo. (London Z. G.)
8. ♀ Malay Sambar Deer (*Rusa unicolor*)	April 29, 1912	April 29, 1912	23 yrs., 1 mo.	23 yrs., 1 mo.	♀ 17 yrs., 4 mo. (Belle Vue Z. G., Manchester, Alive Jan. 1, 1925)
9. ♂ Pigmy Hippopotamus (*Choeropsis liberiensis*)		July 9, 1912		22 yrs., 10 mo.	♀ 17 yrs., 5 mo. (London Z. G. Alive Nov. 11, 1930)
10. ♀ Pigmy Hippopotamus (*Choeropsis liberiensis*)		July 9, 1912		22 yrs., 10 mo.	♀ 17 yrs., 5 mo. (London Z. G. Alive Nov. 11, 1930)
11. ♂ Chapman's Zebra (*Equus burchellii chapmanni*)		Aug. 15, 1913		21 yrs., 9 mo.	(Known to live 28-29 yrs.)
12. ♀ Grant's Zebra (*E. burchellii granti*)		May 21, 1914		21 yrs.	(Same as Chapman's Zebra)

Discussing grizzly bears, Major Flower notes that they are long lived in captivity and that twelve individuals, five of them being left alive, averaged 21 years and 3 months. Of the Family *Ursidae* he remarks in his paper on the longevity of mammals that "Bears of all species live well under suitable conditions of captivity. A selection of 178 individuals, representing all species, show an average life of over 16 years 2 months. The extreme age for a Bear is not less than 34 years."

Major Flower credits the hippopotamus with a "not unusual" ability to live more than twenty years and states that "their potential longevity appears to be over forty years. As far as available figures go, female Hippopotamuses live longer than males both in average and extreme lives."[4]

Dr. Mitchell threw the clear light of fact on the legend of elephant longevity in his paper in 1911.

"Metchnikoff has already pointed out that there is no exact basis for the popular ascription of very high potential longevity to these



Polar bears attain considerable ages and Silver Queen is still able to enjoy a plunge after 24 years and 8 months.

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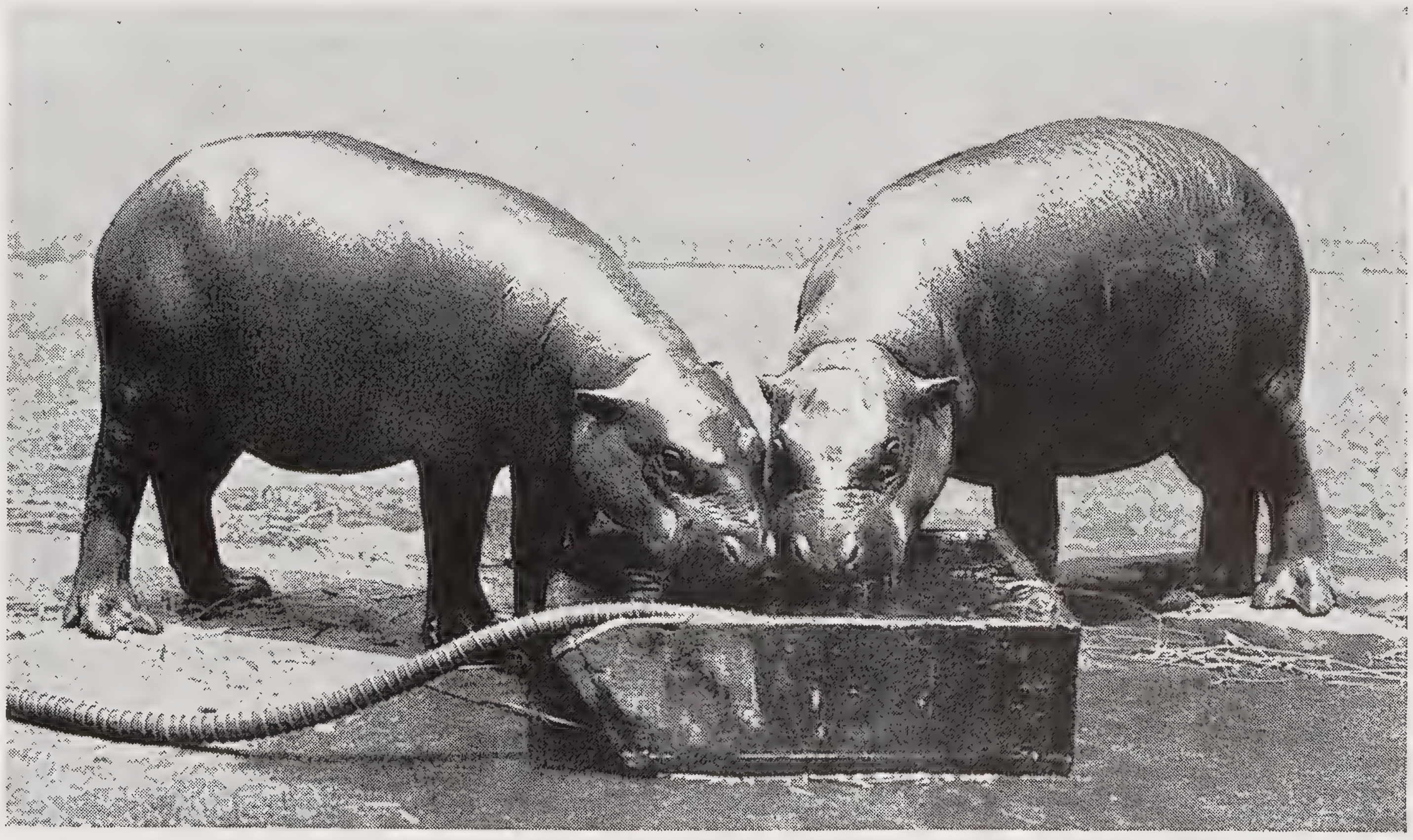
[4] *P.Z.S.*, 1931. p. 225.

(Top) This Kadiak brown bear, one of a pair 27 years and 8 months in the Park, has exceeded the best previous longevity record by four years. (Bottom) Baldy, the bald-faced grizzly, is the oldest mammal in point of exhibition, 31 years and 2 months.

The Malay sambar deer that came to the Park in 1912 *is one of the handsomest of the patriarchs, and has considerably exceeded the European record for longevity.*

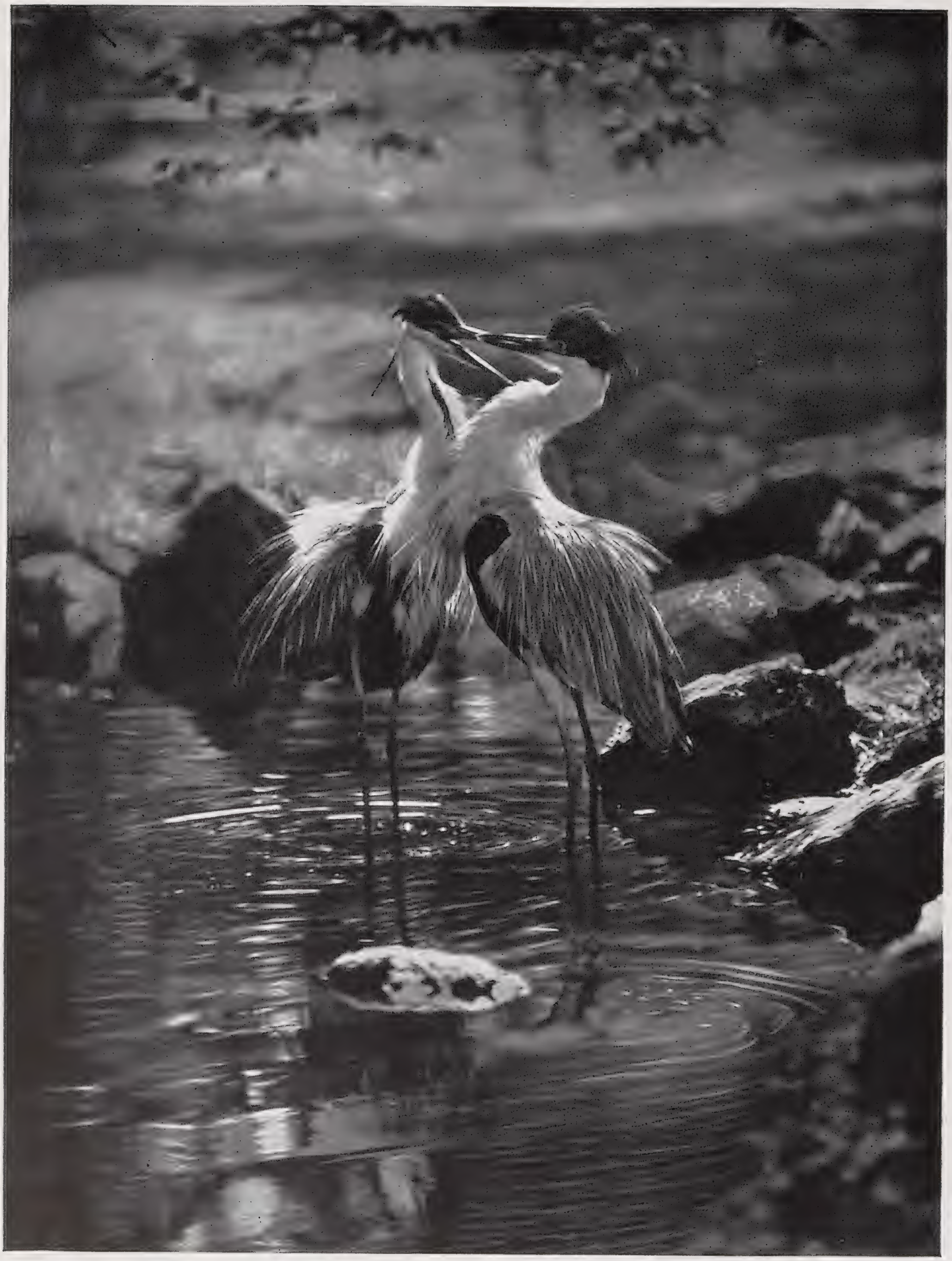
animals," he said. "It used to be thought that they could live for several centuries. Flourens, using his formula based on the age at which the epiphyses unite with the long bones, set down 150 years as the limit of their age. Indian natives ascribe a limit of from 80 to 150 years. On the other hand, the official list of the Indian Government, cited by Brehm, shows that of 138 elephants only one lived for more than 20 years after it had been purchased. Twenty to twenty-five years' duration in a menagerie is regarded as good. The record in the list [Mitchell's tabulation, showing a maximum duration of 24 years 2 months for a specimen of *Elephas maximus*] of about 24 years has been far surpassed by a female Indian Elephant, brought as a young animal by the Prince of Wales from India in 1876, and still alive and apparently in quite good condition in our Gardens, although its age is certainly over 34 years. I agree with the general conclusion of Metchnikoff, that elephants, in proportion to their size, have neither a high potential longevity nor a good viability, not much more than a hundred years being the probable age limit, and twenty to thirty years a fair average duration."



The healthy appetites of these pigmy hippopotamuses gave promise of long life when they arrived in 1912*, and the promise has not been disappointed.*

The findings of Major Flower, based on records of 44 Asiatic elephants outside of India, seem to bear out Dr. Mitchell's conclusions as to the "fair average duration" in captivity, for the 44 specimens exhibited an average duration of a little more than 28 years.

The record of the sambar deer (*Rusa unicolor*) in the New York Zoological Park raises the extreme duration attributed by Major Flower on the basis of eleven specimens in the zoo-



Originally there was a pair of cocoi herons, but only one survives and is setting a record for long life. It came to the Zoological Park in 1913 and has now been constantly on exhibition for a period of 22 years and 1 month.

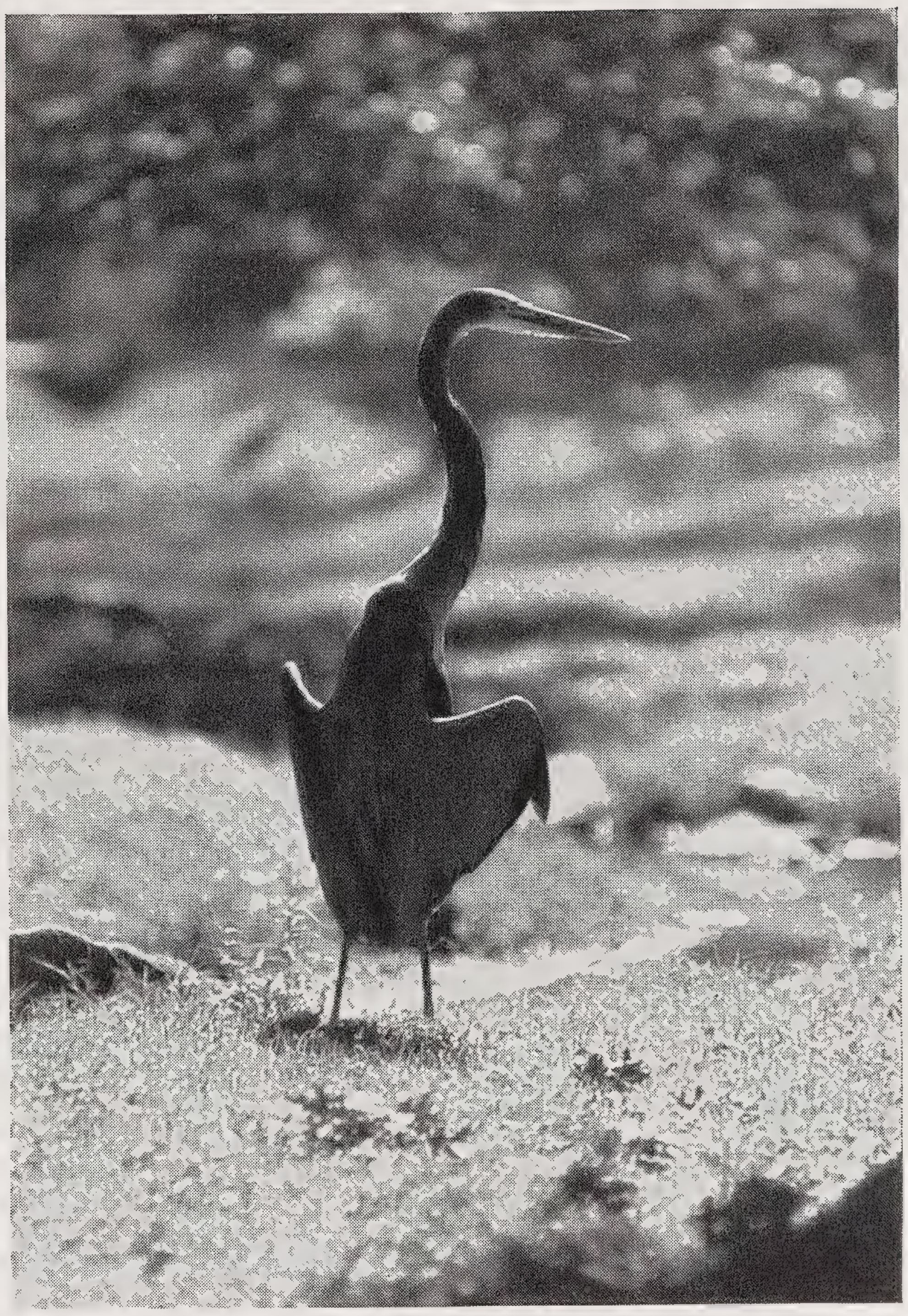
logical gardens of Hamburg, Washington, London, New York, Frankfort and Manchester. In 1931 he was able to cite eleven specimens the oldest of which was 17 years and 4 months, whereas the deer now in our collection, born in the Park, has been under observation for a little more than 23 years.

European records indicate that the pigmy hippopotamus does well and breeds in captivity.

Of Burchell's zebra (Chapman's and Grant's being local forms), Major Flower was able to say that it "frequently lives to over twelve years, and has been known to reach an age of between 28 and 29 years."

The Park's male Nubian giraffe was a patriarch tentatively accorded a place in this article, but he died on May 12 after having been on exhibition since November 22, 1913—a period of approximately 21 years and 6 months. The longest record quoted by Major Flower was that of a female that lived for 28 years in the Antwerp Zoological Garden.

In the course of his survey of bird records, Major Flower was informed of forty-one species among which individual specimens on at least one occasion lived more than thirty years. The list bears out unmistakably his general conclusion that large birds live longer than small ones.



The goliath heron spreads its wings in a sunny glade. The bird was produced by a breeding pair in Amsterdam.

The six birds that have lived in the Park for more than twenty years are the following:

		ACQUIRED	IN THE ZOOLOGICAL PARK (still alive)	MAXIMUM AGE IN FLOWER'S RECORDS (1925)
1.	Griffon Vulture (*Gyps fulvus*)	Aug. 23, 1902	32 yrs., 9 mo.	37 yrs. (Copenhagen Z. G.)
2.	European Pelican (*Pelecanus onocrotalus*)	April 20, 1904	31 yrs., 1 mo.	52 yrs. (Rotterdam Z. G., cited by J. H. Gurney)
3.	European Pelican (*Pelecanus onocrotalus*)	April 20, 1904	31 yrs., 1 mo.	52 yrs. (Rotterdam Z. G., cited by J. H. Gurney)
4.	♂ Cereopsis Goose (*Cereopsis novae-hollandiae*) (Cape Barren Goose)	Aug. 6, 1909	25 yrs., 9 mo.	33 yrs. (Rotterdam Z. G.)
5.	Goliath Heron (*Ardea goliath*)	Dec. 26, 1912	22 yrs., 5 mo.	18 yrs. (Amsterdam Z. G.)
6.	Cocoi Heron (*Ardea cocoi*)	April 3, 1913	22 yrs., 1 mo.	

Eventually, it is to be hoped, a complete tabulation of the longevity records of all the birds, mammals, reptiles and amphibians that have lived out their lives in the Park will be made and then some interesting data will appear in regard to many species whose life span under the most favorable conditions appears to be considerably shorter than the minimum of twenty years arbitrarily fixed for discussion here. As an example might be cited Ricord's humming bird (*Riccordia ricordii ricordii*) which lived in the Park from April 27, 1928, to September 2, 1931, a period of 3 years, 4 months and 6 days. Brief as that period was, compared to the span of many other species, it nevertheless constituted a record for its own species that had not been approached by other zoological institutions at the time.

Major Flower's conclusion in regard to the Old World vultures is that "One may expect a large Vulture, under favourable conditions, to reach the age of 28, and exceptionally to live for very many more years."[5]

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[5] *P.Z.S.*, 1925. p. 1395.

Despite a turbulent career in which he lost an eye and damaged a wing, and survived three mates, the cereopsis goose—bringing up the rear in this family picture—is still a beautiful bird after being on exhibition for 25 years and 9 months.

The extremely high record for the European, or white, pelican which Flower cites (52 years in the Rotterdam Zoological Garden) is stated on the authority of J. H. Gurney and extraordinarily exceeds any other record presented. The Giza Zoological Garden in 1925 had three white pelicans, living at that time, that had been in captivity 25 years and 2 months; the Belle Vue Zoological Garden in Manchester had one, left alive, with a record of 25 years and 9 months, and London reported a specimen that lived 36 years and 4 months.

Of the cereopsis, or Cape Barren, goose, Major Flower stated only that a specimen lived in the London Zoological Garden for 13 years and 9 months and in the Rotterdam Zoological Garden for 33 years. The record of the specimen in the New York Zoological Park reveals a life history so removed from the maximum in "favorable conditions" that it is remarkable the bird has lived as long as he has. On August 6, 1909, the late Col. Anthony R. Kuser presented a pair of the geese to the Park and in 1912 they reared four young, the first breeding record of *Cereopsis novae-hollandiae* in this country. The pair repeated the following year, bringing five young to maturity.

The female was run over by a truck and killed in 1921, for it was the custom to allow the pair to roam at will over the Park except in the mating season when the male was inclined to be pugnacious. Another female was obtained in 1924 but a marauding raccoon killed her in 1930—not, however, without a determined battle on the part of the male. Torn turf and bits of raccoon hair in one of the corrals outside the Ostrich House gave evidence the next morning of what had occurred during the night, and the male also showed signs of the battle. He lost an eye and one wing was damaged.

Nevertheless he recovered and was provided with another mate in 1931, but she met the same fate as Female No. 2, in 1933. Since then he has been mateless.

Flower's record as to the goliath heron, of 18 years, is indefinite and rests upon a note by Curator Lee S. Crandall in the Bulletin for January, 1921, that a pair in the Amsterdam

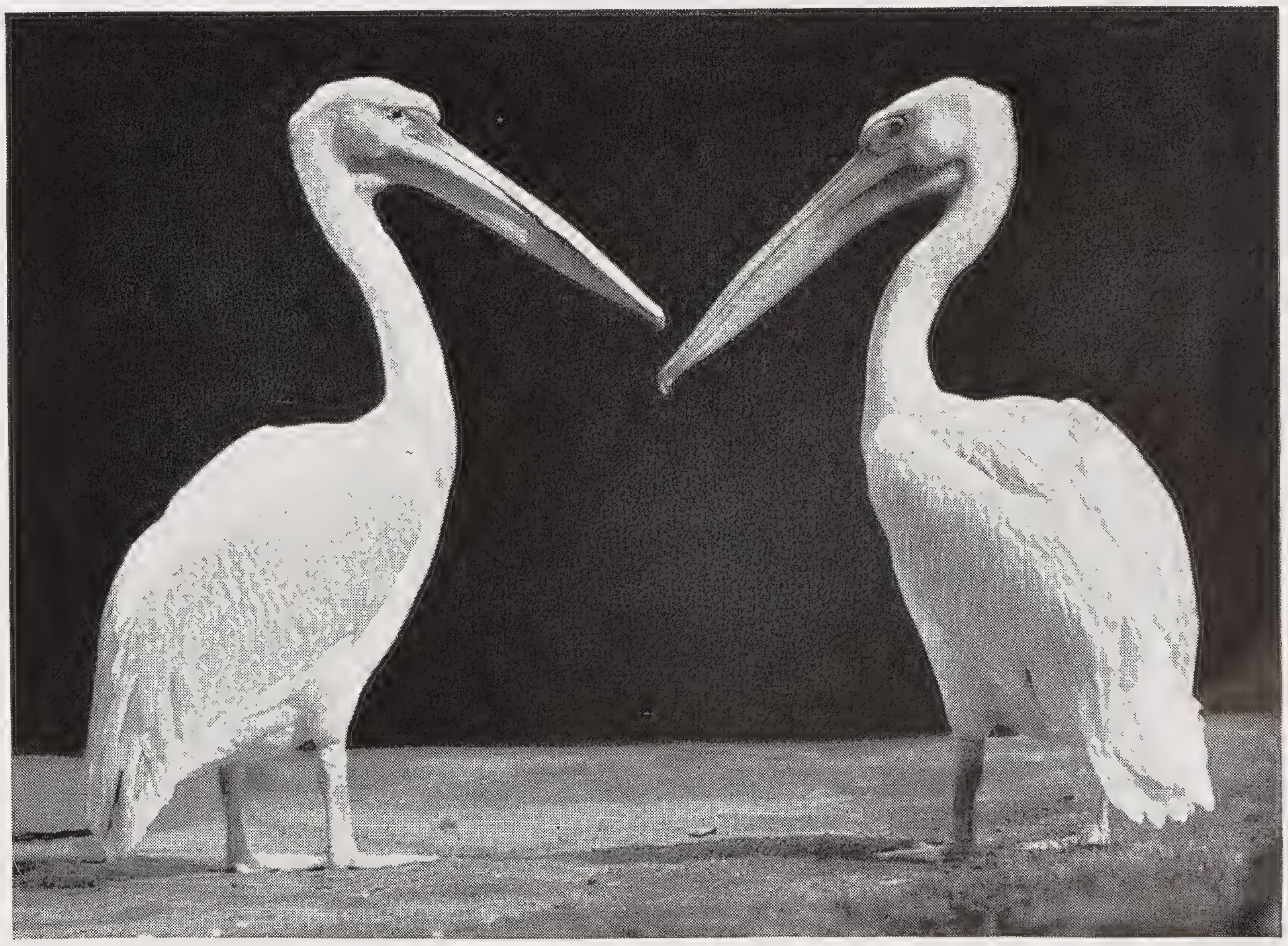
Zoological Garden had been producing "two or three nests of young yearly for eighteen years." It was from that pair that our own goliath heron was obtained and the same pair has supplied many zoological parks. Information as to the actual longevity of the Amsterdam pair is not available. It was during a visit to European zoological gardens in 1912 that Curator Crandall was informed by Inspector Portielje of the Amsterdam Z. G. of their record.

The American alligator that heads the list of the Park's specimens longest on exhibition was brought back, while still in the egg, by Dr. Raymond L. Ditmars from Robertsville, S. C., in the late summer of 1900. Returning to New York from a collecting trip, he brought four alligator eggs in his handbag and in the course of transit one or two were cracked and another, when they were finally placed in incubation in the Park, failed to hatch. But the fourth developed normally and became one of the earliest specimens in the new institution.

The six oldest reptiles in the Park are:

The griffon vulture is the oldest bird in the Park, 32 years and 9 months, but vultures belong to a long-lived family.

	BORN	ACQUIRED	KNOWN AGE	IN THE ZOOLOGICAL PARK (still alive)	MAXIMUM AGE IN FLOWER'S RECORDS (1931)
1. American Alligator .... (*Alligator mississippiensis*)	Oct. 20, 1900	Oct. 20, 1900	34 yrs., 7 mo.	34 yrs., 7 mo.	40 yrs. (Brighton Aquarium)
2. Galàpagos Tortoise .... (*Testudo vicina*)		Oct. 27, 1904		30 yrs., 7 mo.	
3. Galàpagos Tortoise .... (*T. porteri*)		Oct. 27, 1904		30 yrs., 7 mo.	
4. Aldabra Tortoise .... (*T. elephantina*)		1909		26 yrs.	
5. Borneo Gavial .... (*Tomistoma schlegelii*)		June 12, 1912		22 yrs., 11 mo.	
6. South American Tortoise... (*T. denticulata*)		March 26, 1914		21 yrs., 2 mo.	



A pair of European pelicans came to the Park in 1904 and the same pair is still living happily together after 31 years and 1 month. The extreme European record is 52 years, in Rotterdam.

Stories of the extreme age attained by tortoises, like the legends of astonishing longevity in elephants and parrots, must generally be accepted with considerable reservation. Dr. C. H. Townsend said in that connection that "The common supposition that large Galàpagos tortoises must be of great age is unwarranted. Under natural conditions and especially under *favorable* climatic conditions in captivity, they reach a large size in a few years, when the rate of growth becomes slow. There are records of both Galàpagos and Aldabra giant tortoises that lived under observation in tropical climates more than 150 years, when their lives ended upon removal to cold climates. The real length of life is unknown. Certain museum specimens known to have exceeded 500 pounds at death, were doubtless very old."[6]

In recent years several species of Galàpagos tortoises have been established in colonies in the southern part of the United States, in Hawaii and in Bermuda, where their rate of growth can be carefully observed and their duration checked. Eventually, it seems, an authoritative statement of the possible maximum age of the creatures can be made.

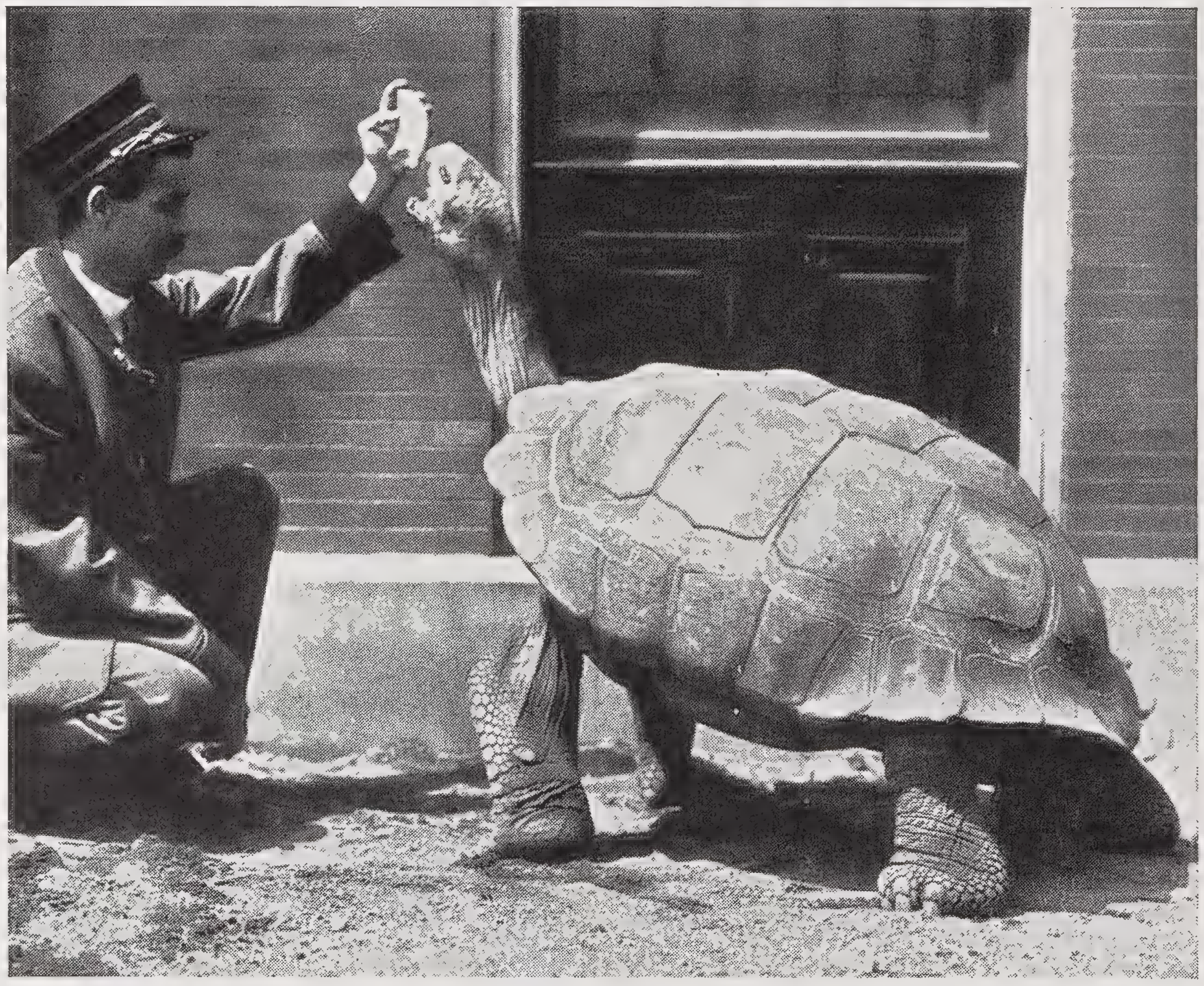
The researches of Major Flower, comprehensive as they are, fail to settle the matter of Old Charlie's exact position among the long-lived alligators of the world. Having been for 43 years under the continuous observation of Dr. Ditmars, to whom he was presented in 1891 by Charles R. Knight, he certainly had a known longevity in excess of any previously recorded. In 1917 the Brighton Aquarium lost a specimen of *Alligator mississippiensis* that had been in the tanks since 1877—a period of 40 years. Old Charlie, moreover, had attained a certain age before he was acquired by the Park's Curator of Mammals and Reptiles. He was a full 16 inches long in 1891.

On the other hand, it has been asserted on behalf of certain alligators lately in the Jardin des Plantes in Paris that one lived 67 years and 7 months, and that another was still alive in November, 1924, in its seventy-third year.

The only conclusion to be drawn is that Old Charlie did very well in the way of longevity, and that he might have done even better had he lived a more temperate life. He was given to battle and around 1900 suffered wounds which exposed his intestines, heart and lungs. Sewed up and returned to his tank, he continued to dominate it and quickly made an apparently complete recovery—and for the first time put on weight and length. On subsequent occasions his battles cost him an eye and part of one jaw.

One advantage indisputably resulted from the demise of Old Charlie, regretful as the Park was at his loss. The alligator pool has been a quieter place since he departed.

No general deductions are of course possible on the basis of the limited number of animals, now living in the Zoological Park, that have been reported here. In a few instances they advance the maximum duration previously recorded, and since the animals are still alive there is a possibility that in some future compilation they will figure on a larger scale as patriarchs of their kind.



Stories about the great ages of giant Galàpagos tortoises must be accepted with reservations. This large one attained most of its size in 30 years.

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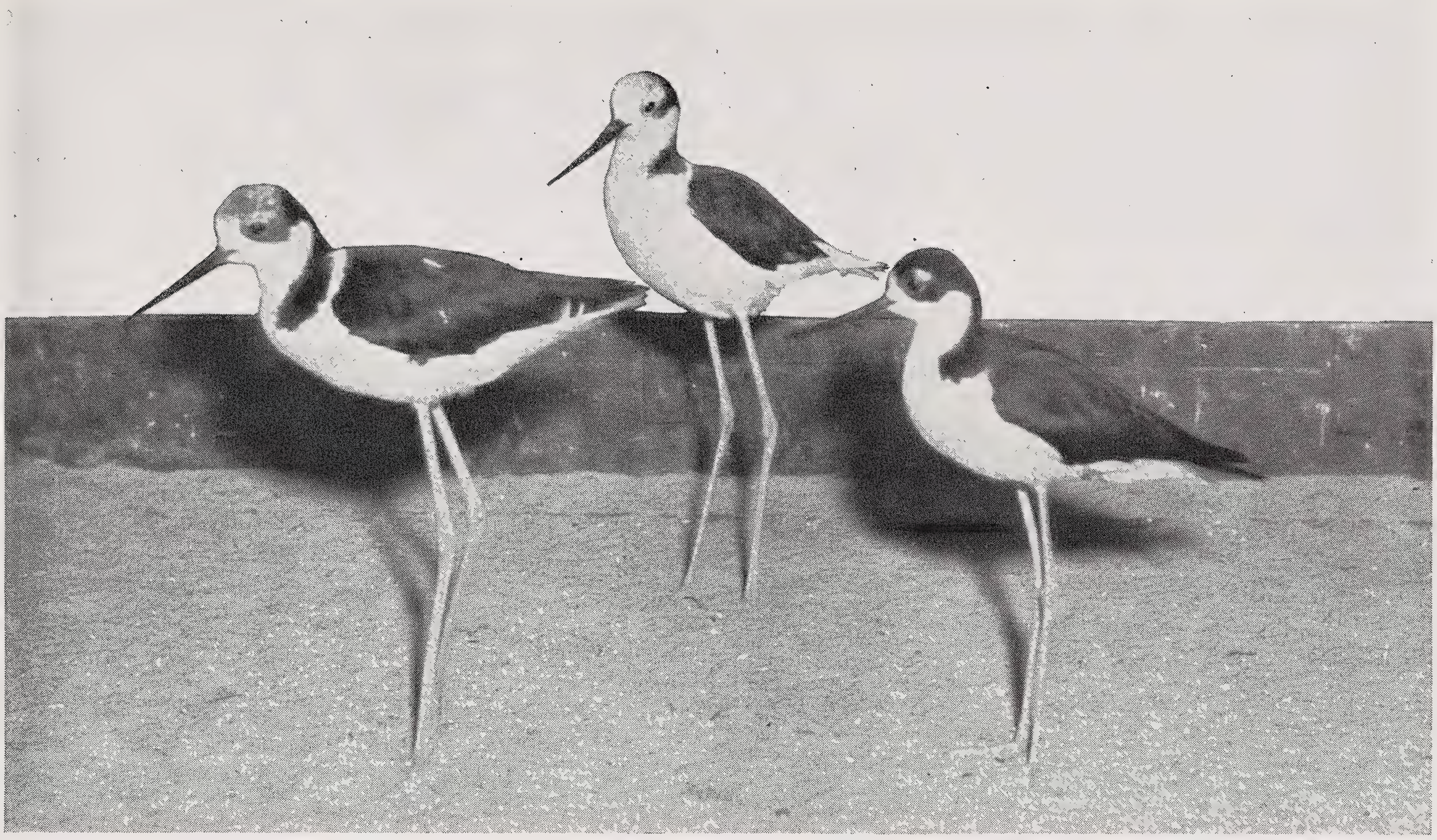
[6] Charles Haskins Townsend: Growth and Age in the Giant Tortoise of the Galàpagos, ZOOLOGICA, Vol. IX, No. 13, June 1, 1931. p. 465.



The Three Graces, as a Chicago illustrator called a collection of black-necked stilts, were released in the Park's indoor flying cage recently. On the left and in the center are two specimens from Brazil; the one on the right is a black-necked stilt.

Stilts Again, After Thirty Years

Lee S. Crandall
Curator of Birds

MOST of the shore-birds — sandpipers, plovers and the like—are especially desirable for zoological collections. The majority are long-lived and hardy, while their active habits and musical call-notes make them particularly attractive to visitors.

European zoological gardens generally are well supplied with birds of this group but in American collections they usually are conspicuously absent. The principal reason for this discrepancy appears to lie in the fact that in Europe, shore-bird netting, particularly in the marshy districts of Holland, has been practised for generations. Experienced men know exactly where, when and how the birds may be taken, so that a certain source of supply is always available. In America, nothing of this sort has ever existed. Any shore-birds that may be secured are caught only by chance, or through the expensive and uncertain means of special commission. Consequently, we are always on the alert for anything of the sort that may appear, and always eager to acquire it.

Besides the numerous typical sandpipers and plovers, the shore-bird group includes a number of curious and often aberrant species, notable for strange and intense adaptations to special modes of life, or for their delicate and graceful beauty. Among the latter, the stilts certainly come first. Slender bodies are perched on legs so long and thin that they seem incapable of supporting any weight at all; lengthy necks are topped off with sharp, attenuated beaks. There is something fairy-like about the stilts; they belong in the fens and marshes where they make their homes. Yet this perfect compatability has not always been apparent to everyone. So great a naturalist as Buffon once scolded Nature for producing this abnormality —a bird with such "enormous defects" that its long legs raised it so high above the ground that it could scarcely get its beak down to find food.

The point is, of course, that an almost equally long neck affords ample compensation. Moreover, the stilt seldom has to reach the ground, since its favorite feeding method is to wade, with its body sometimes touching the water, and to pluck its insect or crustacean food from the surface or just beneath.

In America, at least, stilts are among the great rarities in collections of living birds. In the history of the Zoological Park, up to 1934, only a single stilt was secured. This lone representative of its species was a black-necked stilt (*Himantopus mexicanus*), which arrived from Brownsville, Texas, on December 23, 1903, and expired exactly six days later, never having recovered from the effects of its trying journey. No further stilts appeared here until November, 1934, when two Brazilian Stilts (*Himantopus melanurus*) were obtained, under rather curious circumstances. A local dealer reported, by telephone, that he had just returned from South America with a small collection of birds, and that among them were two which he found difficult to identify. They were black and white, with long bills; their voices were loud and sharp, and the natives used them instead of watchdogs. Nothing could be made of this, but we promised to examine the birds on the following day. However, the solution was not so long postponed; that night, an evening paper carried an excellent photograph of a pair of stilts, with a story on the special ability of the subjects as warners-off of intruders. There was no delay in reaching the bird shop on the following morning and after some discussion, including the defeat of a department store pet shop which had thought the birds would be an attraction, the stilts came into the possession of the Zoological Society.

Three days later, by one of those strange coincidences that are almost routine with us, a lovely black-necked stilt came to join the two Brazilians. Karl Plath, a Chicago illustrator who does bird portraits for relaxation and keeps a fine collection of living subjects, had long been seeking stilts. After many disheartening attempts, he finally obtained three young birds which had been especially hand-reared for him by a friend in the west. Delighted with his acquisition, Mr. Plath kept his three prizes for some months, disdaining all offers of purchase. Then another bird, which he felt he should have, appeared in the market and it occurred to him that an exchange might be made. After some correspondence, completed at about the time the Brazilian stilts arrived, we bought in New York a motmot, shipped it to Chicago, and in return received one of Mr. Plath's "Three Graces." Thus it happens that, after a hiatus of over thirty years, we are able to exhibit a small flock of stilts, representing two species.

Books indicate that the two species are almost identical, except that the Brazilian is slightly larger, with a white band across the shoulders and more white on the face. In fact, however, the legs of the Brazilian are proportionately much longer, and the body shorter and more rounded, so that in life the two species are less similar than would appear from the examination of dried skins.

Frogs and Toads and Tadpoles

A Survey of the Park's Collection of Amphibians

Raymond L. Ditmars
Curator of Mammals and Reptiles

According to the latest scientific lists, there are about 1,500 distinct species of frogs and toads. It would be a little too much to expect that the Zoological Park could exhibit all of them, but for many years amphibians have been well represented in the glass cages in the Reptile House.

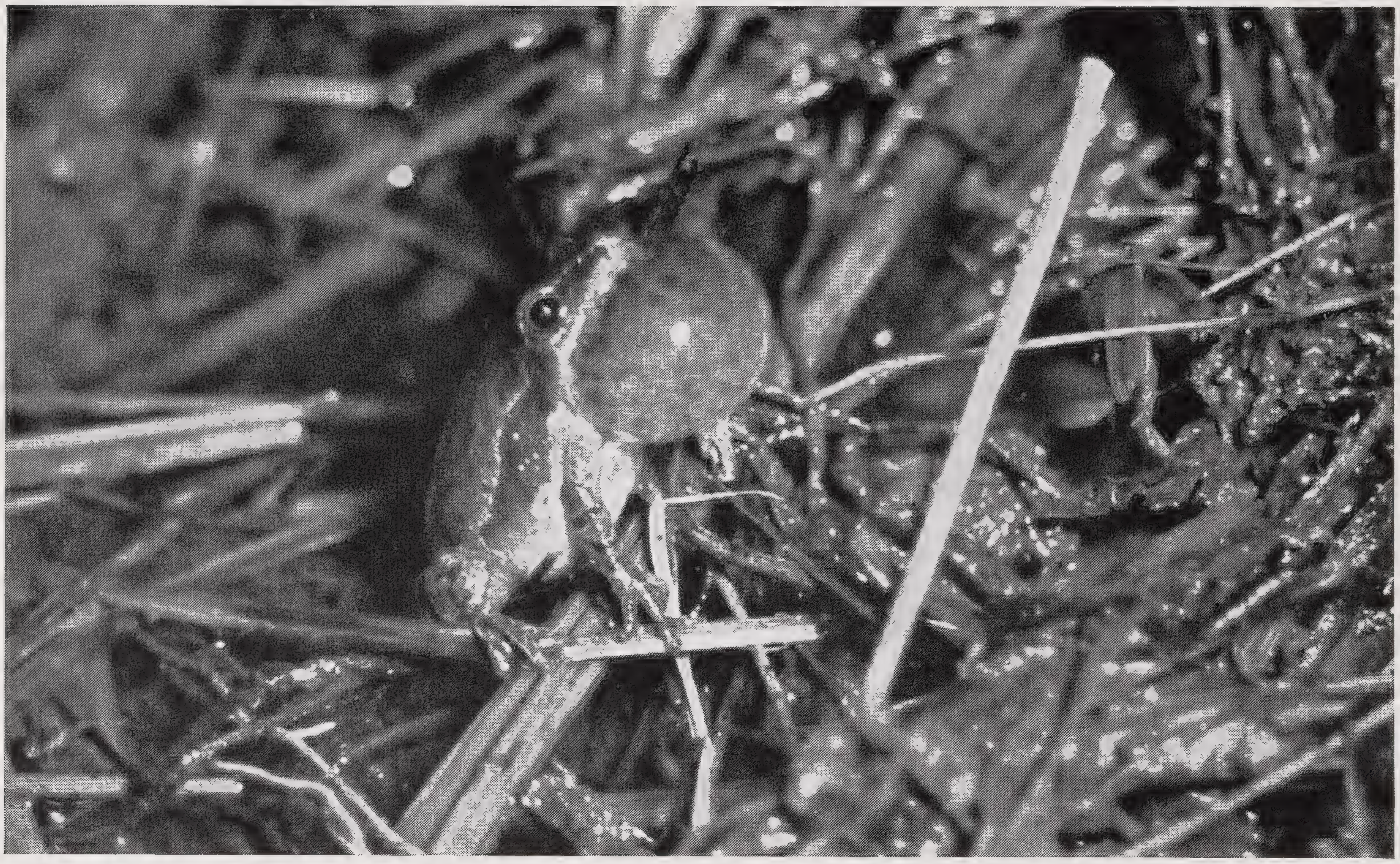
We have had some of the largest and the smallest forms, the most brilliantly colored and the most somber-hued. Today the collection is at one of its most interesting stages and it well repays a detailed study.

Species of frogs and toads are, of course, most abundantly distributed in the tropics, but they occur far north and south of the Equator in temperate latitudes and regions with such severe winters that few other forms of amphibian and reptilian life are associated with them. Their range of size is as great as their distribution, from *Rana goliath,* the giant frog of Africa, whose body is a foot long, weighing as much as a small dog, to species so small that several specimens might hide within a thimble. Their origin is extremely ancient. Remains of frogs have been found in Jurassic strata estimated to contain fossils of life that existed at least 200,000,000 years ago.

The life histories of some species in the present collection are so strange that few other living creatures can match them in eccentricity except certain fishes and some of the insects. Both frogs and toads begin life as aquatic tadpoles and their transition to the air-breathing, or perfect, form is a demonstration in a short lifetime of the process that took place in evolution from fish to air-breathing amphibian. The vicissitudes of the tadpoles are by no means all the same among families of toads and frogs, however.

Their aquatic element may be a puddle in a leaf; it may be the aqueous content of a capsule receiving moisture from the parent's body; it may even be within pockets in the parent's back. Some tadpoles grow to large bulk compared to the size of the parents; a few even exceed their parents in size before they transform. Others are so extremely minute when transforming to the frog or toad form, that they may represent far less than a hundredth of the weight of the adult. There is also great variance in the number of eggs laid by frogs and toads. This seems to be related to the amount of protection afforded by the parent and to the habits of the young. If the latter are not secretive and hazard of destruction by enemies is great, the number of eggs laid is enormous, but only a very small percentage of the progeny reach maturity. Thus the number of eggs, particularly among the largely terrestrial toads, may be more than 10,000, whereas among the smaller frogs the number is less than 50.

Of the local frogs and toads there are nine species, some of which continue to live wild in the Zoological Park. The largest local species is the bullfrog, attaining a body length up to eight inches. The species is found over the greater part of the United States east of the Mississippi River and well into Canada. It is the largest North American frog. The smallest of the local clan is a tree toad, known as Pickering's tree toad, or "peeper." The latter name comes from its loud whistling cries during the breeding season in the early spring. This species is not much longer than one's fingernail, of pale brownish hue, with a dark, cross-like marking upon the back. During the summer it lives in bushes, where it climbs about by means of adhesive disks or "suckers" upon the toes of both feet. It is the first of the frogs and toads to sense the spring, and as it hibernates in the immediate vicinity of water, it wakes from its winter sleep with the first warm days and mates in shallow marshes, where the eggs are laid. The power of voice of these tiny creatures is remarkable. Swampy places resound with their cries. Their chorus is a sure harbinger of spring and the cheery sounds may be heard well in advance of settled spring weather. A sudden freeze may silence them temporarily, but frosty weather is fast waning when the "peepers" start their mating calls. Each whistling sound is accompanied by an expansion of the elastic throat to half the size of the owner's body.



When the spring peeper, or tree toad, makes his cheerful mating music, his swelling throat pouch is almost as large as his diminutive self. His trill is a familiar sound on spring evenings in ponds and swamps. Later he takes up arboreal life.

Between the miniature peeper and the big bullfrog, with its sonorous bass note, the local frogs are quite evenly stepped along in size. The gray tree frog is about an inch and a half in length. The wood frog is a bit larger and a good example of protective coloration. It is largely terrestrial, living among the fallen leaves of damp woods, and being of a bronze hue it is very difficult to detect unless it moves. The tadpoles of this frog appear to require pools of clear water which collect in the woods from melting snow plus the spring rains. Such conditions are not general in wooded places, hence the distribution of the wood frog is scattered and confined to areas precisely suited to its needs. It does not occur in the woods of the Zoological Park, but is quite common in the timbered stretches atop the Palisades of the Hudson. The pickerel frog and the leopard frog are larger and strongly marked with large, dark spots. The former may be distinguished by the orange hue beneath the thighs. Next to the bullfrog, the largest local species is the pond frog or green frog, persistently aquatic. The males give voice to cheerful croaking throughout the summer.

Two species of toads occur locally, the common toad and the spadefoot toad. Both are becoming rare except in undisturbed, back country areas, because of drainage of areas of shallow water which are required for development of the tadpoles. The eggs of toads differ from those of frogs in that they are laid in strings rather than in masses. The transformation of the toad is very rapid, the tadpoles remaining extremely minute and delicate and the transformed toad being barely a quarter of an inch in length. For that reason they require warm, shallow water and absence from too numerous enemies in the shape of carnivorous fish. With all tadpoles of frogs and toads, the hind limbs are the first to appear, and after their development the growing forelimbs are thrust through folds of skin. The tail is not "dropped off," but is absorbed into the body and serves as nourishment while the mouthparts of the tadpole are changing to those of the air-breathing frog.

It is among tropical frogs and toads, of course, that we have exhibited the most spectacular kinds. One on display for more than five years is the strangest in form and habits of any ever in the collection. This is the giant horned frog, *Ceratophrys ornata,* of southern Brazil and the Argentine. With a few other eccentric species, it belongs in a family by itself, the members having characteristics both froglike and toadlike. All are terrestrial and solitary except during the breeding season. During the day they live in nestlike hollows in the debris of the forest floor, and at night they come forth in search of insects or even to stalk small rodents. Our Brazilian horned frog is almost circular in outline and approximately six inches in diameter, with prominent horns over its eyes. It has an enormous mouth with strong jaws, and surprising enough for a frog, it is bold and will leap at one's fingers in an effort to bite. By experience the writer can vouch for the strength of its jaws, which can inflict an injury equivalent to that from a fair-sized turtle. During such demonstrations the angry amphibian utters barking sounds like a small dog. Our specimen can swallow a half-grown rat, entire.

Photo by C. W. Leister

The common tree frog is well adapted by color and size to be inconspicuous when it takes to the trees.

The most attractive frogs in the collection belong to the genus *Leptodactylus.* They occur in Central and South America and the southerly West Indies. These frogs are of fairly large size and some of the mainland species are marbled with strong colors, the pattern appearing as bright as if it were painted. A species found on the island of Dominica, now represented in the collection, is of shining, golden-bronze. When he first heard the calls of these frogs in the tropics, the writer was much impressed by their deep, booming voices during the mating season. Investigating the sounds with a jack-lamp, it was startling to see the red glow of the frogs' eyes like a freshly-fanned ember. Among members of this genus a curious habit has been observed in the care of the eggs. They

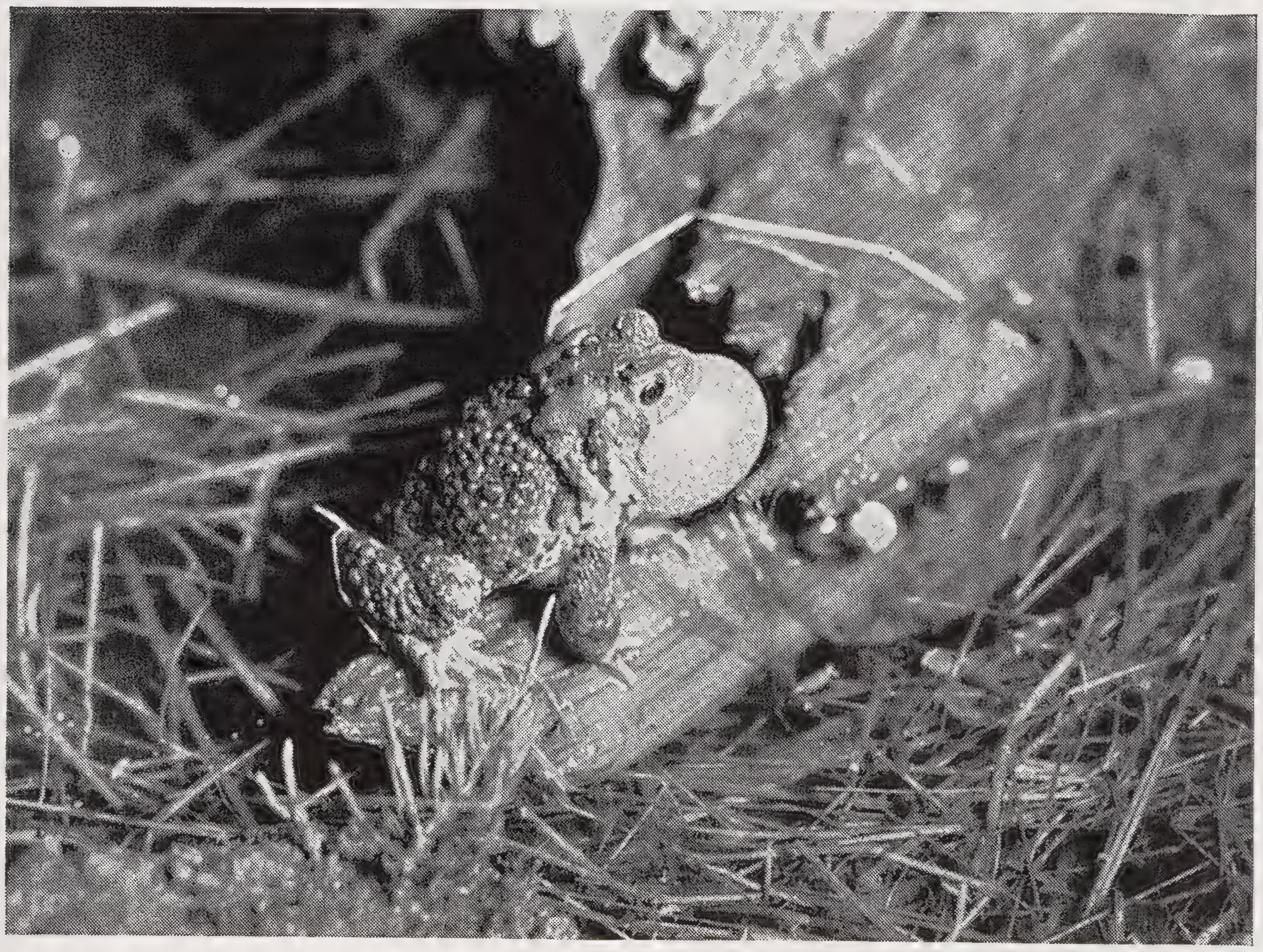
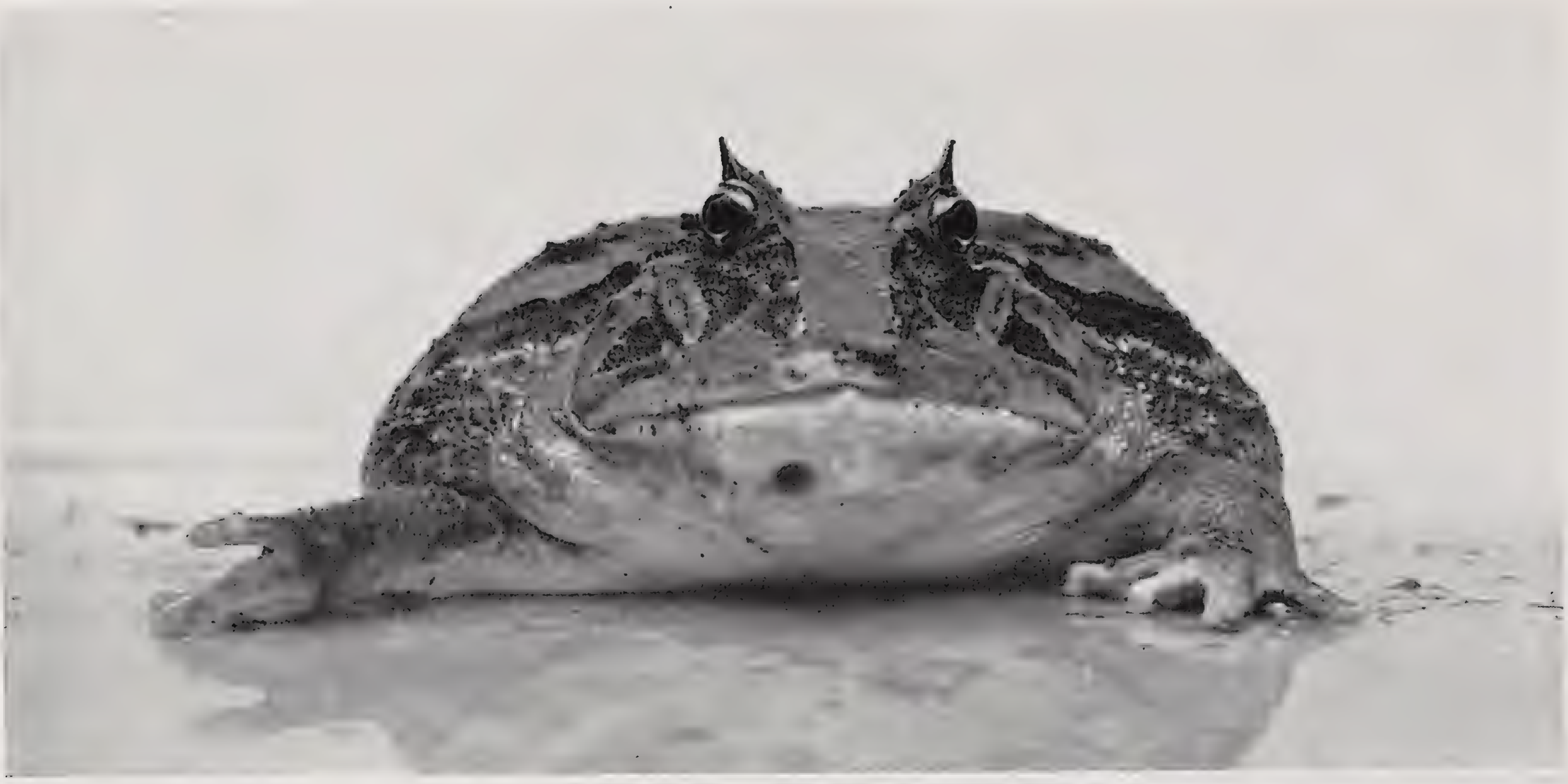
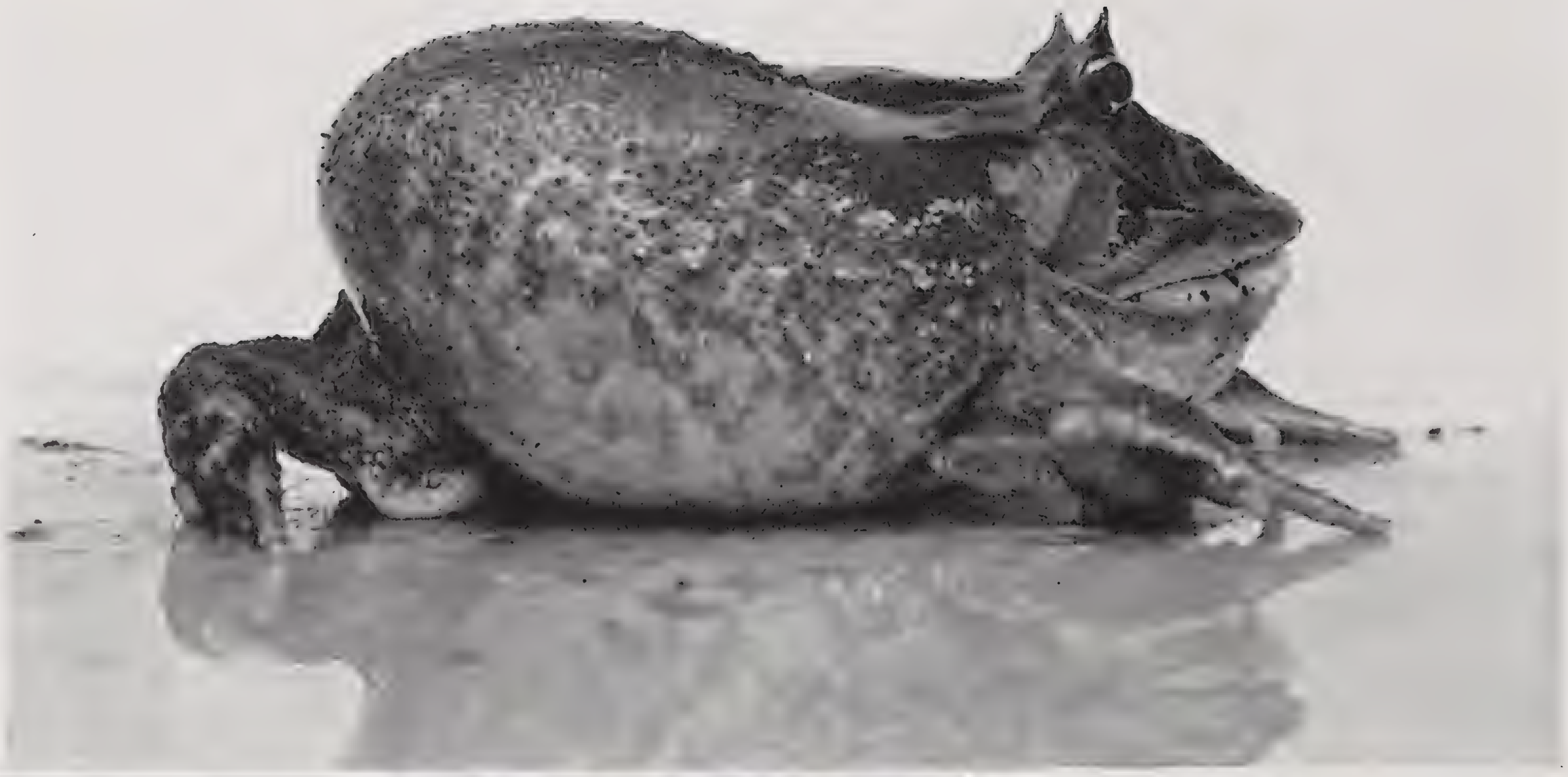


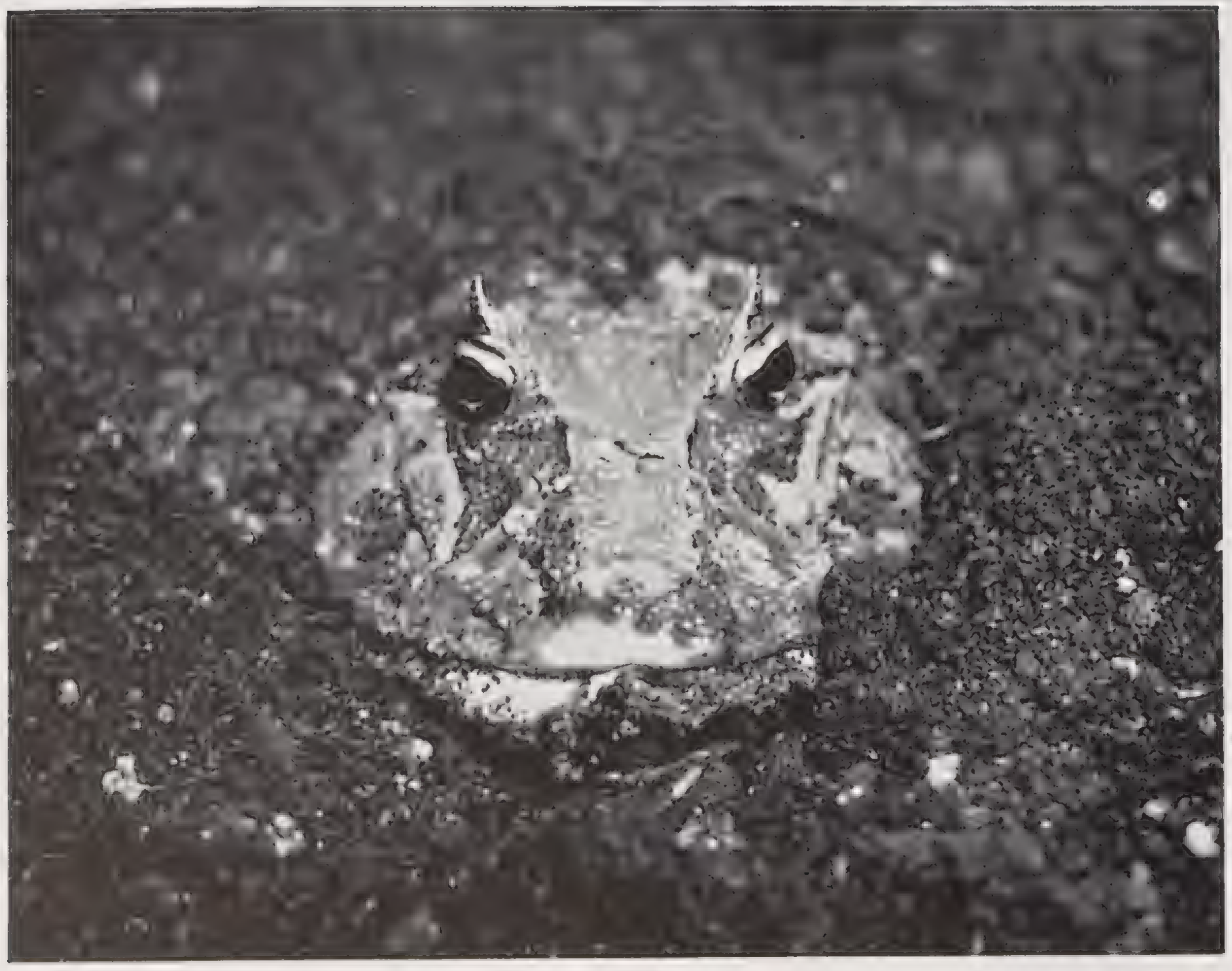
Photo by C. W. Leister

The trilling song of the common toad is heard in late spring. As with other species, only the males sing. The throat pouch remains inflated for the duration of each song.



The Brazilian horned frog is as fierce as it looks and quite willing to bite at one's fingers. The poses above and at the right show its flat and almost circular shape.





Except when it is abroad at night in search of insects or small rodents, the giant horned frog lies almost buried in a nest in the debris of the jungle floor.

are deposited in shallow water at the edge of a pond or swamp and protected by a wall of mud constructed by the frog. In this enclosure the tadpoles hatch and acquire strength and activity and by the time they are able to evade enemies, the rainy season comes with its torrential downpours, breaks away the restraining wall of mud, and the tadpoles are released to complete their development into frogs.

Of more remarkable character, however, are the habits of the Surinam toad, *Pipa americana,* from northern South America. These strictly aquatic creatures, four or five inches long and as flat as a pancake, are also on exhibition in the Reptile House. When the eggs are liberated in the water, they are pressed by the male upon the female's back, where they become adherent and encased in depressions. Over these a film is formed to create a cell in which the tadpole hatches and transforms to a tiny toad. When it is perfectly developed, it is a miniature form of the parent. Then it breaks from the cell and goes its way without further parental contact.

Xenopus, of southern Africa, is another strictly aquatic toad, but it lacks the strange breeding habits of *Pipa.* It never leaves the water, and has huge, webbed, hind feet for rapid swimming. During the breeding season the specimens in the Park utter sounds while two feet beneath the surface of the water. These sounds are like the tapping of a coin on the end of a finger—a metallic jingling that may be heard at least twenty feet from the tank.

Pseudis paradoxis, a South American species, is an example of an extraordinary tadpole state. Specimens of this frog were brought back the past summer from the island of Trinidad. *Pseudis paradoxis* is a small frog, not more than three inches long, and nothing in the appearance of the adult would indicate anything unusual in its development. Nevertheless, all of the half dozen species of the genus to which this frog belongs attain huge size as tadpoles. These giant tadpoles may be six to eight inches long and so utterly out of proportion to the moderate-sized frog to which they are ultimately transformed that early naturalists were inclined to think they represented some big species of frog not as yet known in the adult stage. But the truth of the matter is that as the tadpole of *Pseudis* starts to grow limbs and absorb the tail, the whole creature shrinks into more compact form.

Of tree toads, or, as some authorities prefer to specify, tree frogs, the Reptile House usually has a fair series on exhibition. These creatures form the distinct family *Hylidae.* There are slightly more than 200 species, widely distributed in tropical and temperate regions of both the Old and the New World. The species are provided with toes and fingers dilated into the form of adhesive disks, enabling them to climb smooth, vertical surfaces and cling to leaves. Hence the greater number of species are largely arboreal. Most of them are small, some being less than an inch in length, but a few, such as *Hyla maxima* of northern South America and *Hyla vasta* of Haiti, reach a length of five inches. Their color and patterns are vivid with green predominating—a protective hue in a life amid foliage. Others, however, are brown or gray and when resting against the back of a tree they look very much like a

The twanging, deep-voiced bullfrog is the largest local species of frog and is common over a great part of the United States east of the Mississippi.

Some of the tropical South American tree frogs are extremely handsome and agile creatures. This specimen is almost acrobatic in its pose on a small limb. The adhesive disks on its toes enable it to cling to almost vertical surfaces.

patch of lichen. The cries of the tropical species are loud and extremely varied, ranging from raucous squawks and growling sounds to prolonged chatters or sounds like a stick beating upon a hollow tree. Others produce melodious, bell-like notes, or whistle with remarkable shrillness.

Some of the skin secretions among toads and frogs are highly toxic and this is particularly evident among the small species of the family *Dendrobatidae,* which is represented by three genera, one in South America, one in westerly Africa and another in Madagascar. The species average under an inch and a half in length and all are so vividly marked and colored that they appear when flattened and resting, more like ornaments carved to decorate a big signet ring than like living frogs. The smooth skin is usually black or dark brown, and marked over this, or in large patches, are the most vivid shades of red in some species and green or blue-green in others.

Dendrobates tinctorius, of South America, secretes a highly active poison in its skin. "Drop for drop," if it can be so designated, it appears to be more highly active and more toxic than snake poison.

The strictly terrestrial toads are always of keen interest as captives. They appear more alert and intelligent than frogs and are particularly hardy. They form another family, the *Bufonidae.* The European natterjack toad is particularly interesting, as it seldom hops, but stalks its insect prey by curious walking gait.

The largest toads now on exhibition in the Park represent a species known as the marine toad, *Bufo marinus,* occurring widely in Central and South America. Specimens brought back from Demerara the past summer are eight inches long, but a reliable observer told us that the species grows much larger and occasional specimens are so big that they will cover the bottom of a 16-quart pail. Our smallest species is the oak toad, *Bufo quercicus,* of Florida, which lives in a burrow so small it will barely admit the end of a finger.

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NEW YORK ZOOLOGICAL SOCIETY

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All pictures not otherwise credited are from the photographic collection of the New York Zoological Park.

Index for 1934

A complete index of articles, illustrations and text matter in Volume XXXVII of the Bulletin for 1934 has been printed and a limited number of copies is available without charge to Members of the Society or subscribers who will write and ask for them. Indexes of a few earlier volumes will also be supplied as long as they last. Address requests to the Editor.

Aard-Vark

For the second time in its history the Park is exhibiting an aard-vark, the "earth pig" of the Boers. By no means as common in South Africa as it once was, rare in Zoological Parks, the present specimen offers an unusual opportunity for visitors to see a most interesting animal.

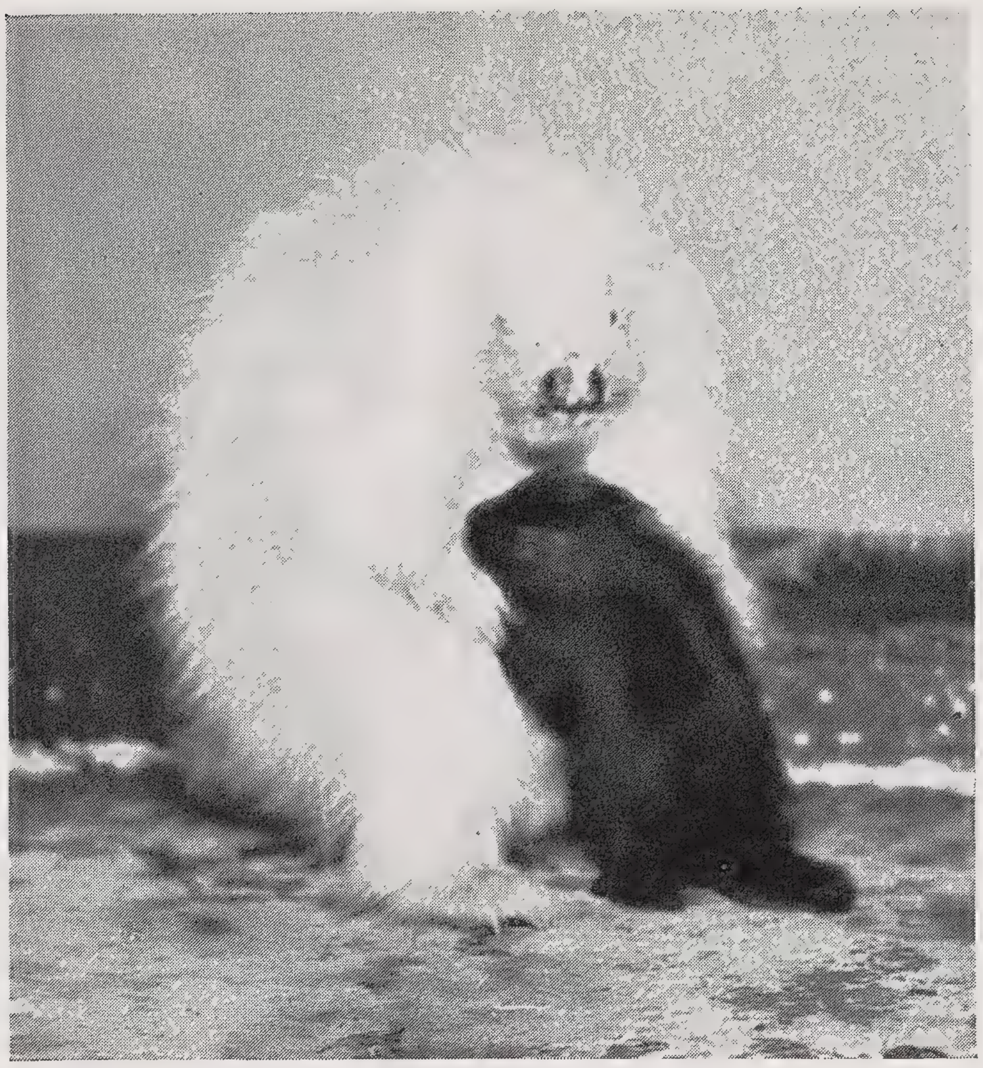
Instead of being related to the pigs as a group, as its name and to some extent its appearance would indicate, the aard-vark is classified as the sole representative of a rather ancient group of mammals and is believed to be allied to our present-day edentates, such as the ant-eaters and armadillos. Scientifically it is known as *Orycteropus aser.*

Being an ant-eater—and ants, or termites—being difficult to supply in quantities of four or five pounds a day, the aard-vark's diet presents some problems. It is fed on diluted evaporated milk, the yolks of eggs, and bread crusts, the latter mixed with the eggs and milk.

Study in Black and White

Albino animals are, generally speaking, not extremely rare either in nature or in Zoological Parks and certain of them may be so common as to excite little attention. The Canadian porcupine is virtually in that class but an albino female that had been on exhibition in the Small

The new aard-vark creates a dietary problem, for its habitual food in its South African home is said to be ants and termites exclusively. However, a substitute food has been found.



The normally pigmented baby porcupine—almost jet black—is in strange contrast to its albino mother.

Mammal House for some months drew considerable attention to herself on May 10 when she gave birth to a normally pigmented baby—a small replica of herself except that it was jet black with a sparse mixture of white hairs.

The baby was born with its eyes open and with its quills soft and pliable. A few hours after birth they had begun to stiffen, however, and by the second day they were firm enough to cause the attendant in the Hospital, where the mother and her baby were transferred, to be cautious in handling the baby.

The young porcupine appears to be healthy and strong and will soon be ready, with the mother, to be returned to exhibition.

Books of Interest

THE HAWKS OF NORTH AMERICA. By John Richard May. Illustrated by Allan Brooks and R. T. Peterson. 171 pages with 37 colored plates, 4 black and white plates, and numerous maps. The National Association of Audubon Societies, 1935. $1.50.

"The Hawks of North America," by John Richard May, is published by the National Association of Audubon Societies frankly as propaganda for the protection of hawks and, incidentally, of owls as well. This declaration of purpose might lead one to expect the material to be presented from a somewhat biased viewpoint but Dr. May has strengthened his case immeasurably by maintaining a completely fair and unprejudiced attitude throughout. While standing staunchly for those species well known to be chiefly beneficial, he freely admits the depredations of the comparatively few habitual bird-killers.

In a brief statement of policy, the Audubon Societies make six principal points, which are, in effect, as follows: to oppose extermination of any bird species; to protect, at all times, rare or beneficial hawks and owls; to permit the killing of any hawk or owl only when the individual is known to be destroying property; to condemn the use of the pole trap; to promote protection of the raptorial birds, through education and legislation. Dr. May's book strikes a strong blow for the advancement of these aims, and should convert many enemies of hawks, including sportsmen, who are their chief persecutors. Even the professional gamekeeper, inveterate destroyer of "vermin," will think twice before he sets another pole trap, or draws a bead on a rat-hunting red-tail.

The colored plates, made from paintings by Major Allan Brooks, firmly establish this artist as the foremost successor to the late Louis Agassiz Fuertes. All are beautifully done, but there is some variation in treatment, a few being noticeably hard, in contrast to others more pleasingly soft and lovely. Mr. R. T. Peterson's excellent silhouettes of flying birds seen from below include elaborations of his previous work in this field and if carefully studied, will make field identification quite simple.

The Audubon Societies, the author and the artists are to be congratulated for the production of a work eminently useful, as well as technically and artistically well done. L. S. C.

INFANTS OF THE ZOO. By E. G. Boulenger. 146 pages with 50 illustrations. E. P. Dutton & Co., 1935. $2.50.

Many hundreds of young animals have been born in the London Zoological Garden and fifty striking photographs of the parents and their often quite dissimilar offspring have been selected by Dr. Boulenger, the Director of the Zoological Society's Aquarium, and published here together with a foreword in which he cites some of the Garden's experiences in rearing the young creatures.

PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-IX and XI-XVIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Some Books by Members of the Park Staff:

Beebe: HALF MILE DOWN. 344 pages, 123 illustrations and 8 colored plates. 1934. $5.

An account of the deep-sea explorations of the Department of Tropical Research in the bathysphere.

Blair: IN THE ZOO. 195 pages, 55 illustrations. 1929. $2.50.

Entertaining and informative animal stories drawn from long experience in the Zoological Park.

Crandall: PARADISE QUEST. 226 pages, 52 illustrations. 1931. $3.50.

A vivid description of a successful expedition to New Guinea in search of Birds of Paradise for the Park collection.

........: PETS AND HOW TO CARE FOR THEM. 296 pages, 96 illustrations. 1930. $2.

A practical manual for everyone who keeps animal or bird pets.

Ditmars: CONFESSIONS OF A SCIENTIST. 241 pages, 39 illustrations. 1934. $3.50.

Adventures in collecting and maintaining animals in the Zoological Park.

........: SNAKES OF THE WORLD. 207 pages, 84 pages of illustrations. 1931. $5.

A comprehensive book of reference on the snakes of the world.

Leister: PRESENT DAY MAMMALS. 74 pages, 105 illustrations. 1931. $1.

A valuable classification and reference book for schools and students of zoology.

All these books and others by the same authors may be obtained from the New York Zoological Park. For book express add 15 cents postage for each volume.

A classified list of the publications of the Society, with subject headings of articles printed in the *Reports, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. MITCHELL, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

Clark and Fritts, New York, Printers.

XXXVIII, No. 4 July-August, 1935

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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EVER since its founding in 1895 the New York Zoological Society has attracted the active interest of persons who believe, with the founding group, that instruction and entertainment and important scientific achievement can go hand in hand through the maintenance in New York City of well-balanced collections of mammals, reptiles, birds and fishes from all parts of the world.

The Society is taking a prominent part in the conservation of wild life all over the world but especially in North America. The work it has done in the collection of Heads and Horns is of great scientific value as are the accurate pictures of wild life in its galleries.

In the Society's work of gathering, maintaining and exhibiting its collections, as well as its constant efforts in behalf of conservation of wild life everywhere, every Member shares, and through the privileges of Membership and the Society's publications is rendered an accounting of the work in which he participates.

The New York Zoological Society invites the Membership of all persons who wish to lend financial support to the purposes for which the Society was founded and to cooperate in a tangible way toward the future development of the Zoological Park and the Aquarium.

Annual Membership in the Society is $10, renewable annually. Life Membership may be obtained for $200. A contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

All classes of Members are entitled to receive every periodical publication, the privileges of the Administration Building with its lounges and reception rooms and gallery of paintings of animals, to attend lectures, open meetings and entertainments, and to be admitted free to the Zoological Park and the Aquarium every day in the year.

Application for Membership may be made on the inserted form, may be given to the Director of the Zoological Park or the Director of the Aquarium, or may be mailed directly to the Secretary, New York Zoological Society, 101 Park Avenue, New York City, for action by the Executive Committee.

The Zoological Park is open every day in the year from 10 o'clock in the morning to one-half hour before sunset. Admission is free every day except on Mondays and Thursdays when an admission fee of 25 cents is charged for adults and 15 cents for children between the ages of five and twelve. These days have been set aside primarily for the benefit of Members and their friends who are admitted free on tickets issued with Membership, so that the collections may be seen to the best advantage. All holidays are free.

The Aquarium also is open every day in the year. From April 1 to September 30 its hours are 9 o'clock in the morning to 5 o'clock in the afternoon, and for the remainder of the year, from 9 o'clock in the morning to 4 o'clock in the afternoon. No admission is charged at any time during the year.

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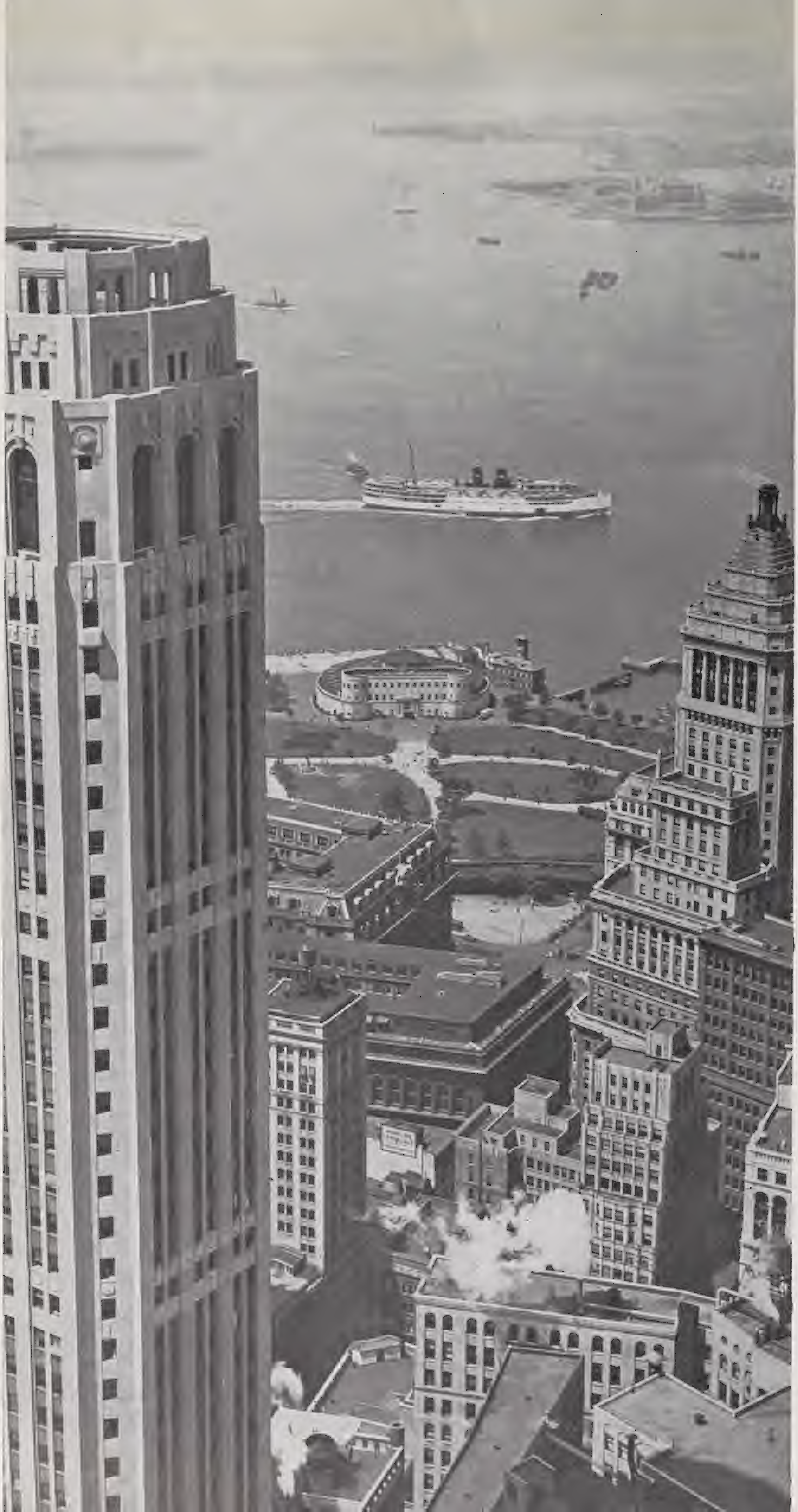

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BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

Vol. XXXVIII July-August, 1935 No. 4

The Aquarium and Research

C. M. Breder, Jr.

THE casual visitor to the exhibition hall of the Aquarium scarcely, if ever, realizes that the historic building houses more than a display of aquatic creatures that are variously described as beautiful, peculiar or bizarre. But those whose interest leads them to ask questions concerning what goes on "behind the scenes" are often amazed at the amount of physical equipment and the complexity of the operating details necessary to maintain an exhibit which is primarily intended to be of educational value.

The pumps, motors, filters, heaters, miles of pipe and the constant attention to the matter of feeding, treating and caring for such a varied assemblage of often exacting animals are not generally brought directly to public attention. However, it is not the purpose of this account to discuss either the equipment or the problems of the engineers, fish culturists, pathologists and others who are charged with the various details of maintenance. It is, rather, the present purpose to discuss the broader background on which this all rests and without which the institution would soon become static.

Of this aspect of the institution's activity the casual visitor is even less aware. Without a background of what may be covered by the general term of "research," no advancements in technique could be effected, and although the visiting public does not ordinarily realize it, without doubt a lack of such activity would eventually result in dissatisfaction of the visitors by lessened effectiveness of exhibits.

As in all such matters, it is impossible to separate practical research problems from those that ordinarily might be considered entirely academic. In addition to purely institutional matters there has been an increasing amount of cooperation with other scientific organizations. This in itself has done much to expand the useful sphere of influence of the Aquarium in a most valuable direction, including as it does a considerable contact with medical researchers.

The New York Aquarium, from the time it was brought under the jurisdiction of the New York Zoological Society in 1902, naturally became committed to a policy of scientific study. The products of its studies have been numerous and varied, although it was not until 1927 that reasonably adequate quarters were provided for laboratory work. Since then a fair amount of apparatus has been acquired, so that today a variety of problems may be investigated with comparative facility. Aside from studies carried on by the permanent staff, space has been made available to visiting students. The published results of both groups have thus far been confined almost entirely to technical reports. It is one of the purposes of the present account to sketch the chief features of some of these in non-technical language so that the layman may more fully understand the reasons for undertaking certain studies and be in a better position to appraise their value. To this end a number of representatives of other institutions who have made use of Aquarium facilities have been invited to contribute short accounts to this number of the BULLETIN, dealing with their particular work. The reader is referred to the other articles, in which they may read in the students' own words about their particular studies. The more general features and the work of the staff are discussed in this article. With this foreword the problems of most acute value to the Aquarium in its maintenance of an exhibit may be considered.

When the Aquarium was taken over by the New York Zoological Society the water supplied to the marine fishes was pumped from New York Harbor. It soon became apparent that this was far from suitable, especially for species accustomed to tropical reef waters. In 1907 a large reservoir of 100,000 gallons capacity was built under Battery Park. In this was stored sea water brought in lighters from the open sea. That water was then circulated through the tanks, filtered and returned. This brought about a great reduction in the mortality rate and improved the general well-being of the marine fishes, as well it might when it is considered that the New York Harbor water is not very saline, because of the influx of the Hudson River, and is heavily contaminated with factory and other wastes.

A closed system, however, has its own drawbacks. The waste products of the fishes themselves accumulate and react with the various salts present in sea water. The resulting solution is unsatisfactory for most fishes and if the reactions go far enough it may be fatal. A satisfactory method for the rectification of this condition was not worked out for practical application until 1929. The establishment of this improvement is largely due to Dr. Homer Smith, at that time working on Aquarium specimens in pursuit of studies concerning the normal functioning of the fish kidney. Although the corrective application is exceedingly simple the working out of the method involves a rather elaborate chain of chemical events.[1] As applied now at the Aquarium, certain readings of the chemical state of the sea water are made in the laboratory on a Van Slyke apparatus, and then, with appropriate calculations, the sea water may be corrected by the addition of a proper quantity of bicarbonate of soda. The improvement this treatment made in the marine collections was most marked and it is with considerable satisfaction that we are able to report that both the Chicago and Philadelphia Aquariums have since adopted it. As everybody knows, bicarbonate of soda is frequently indicated for digestive troubles (acidosis). The effect on an aquarium of fishes is actually not dissimilar. If an entire aquarium circulating system is compared with an animal with imperfect elimination (one of the causes of acidosis), it will be seen that the effect is much the same, for aquarium systems as now constituted are unable to avoid an accumulation of acid wastes in solution and an "acidosis" sets in, by which the alkaline reserve is broken down. As with all such analogies it cannot be carried too far without involving real points of difference, but the above gives a concept of the basic principles involved.

Since this treatment has become an established routine the basis of a further improvement has arisen but at this writing is not completed. A discussion of it, however, serves to show the often unexpected value of "abstract" studies and the advantage of cooperating with institutions that are committed to other biological matters. Pursuing certain studies involving the parathyroid glands in relation to lead poisoning, Dr. W. Antopol became interested in fishes, since they are the only vertebrates that are not supposed to possess any. Although they have the thyroid, the accompanying parathyroid is apparently completely absent. The question arose as to how fishes carried on the functions commonly referred to these glands in other vertebrate animals. Certainly such an investigation, while charged with biological interest, could hardly be expected to yield anything of practical value to aquarium management. However, there are indications that fishes are much more sensitive to lead poisoning than any of the higher vertebrates. Ridiculously small doses of lead salts in aquarium water were shown to be harmful and slightly larger ones proved fatal in direct proportion to the concentration. Now it has been more or less general, in America at least, to use lead pipe for aquarium purposes. A check on the possible amounts of lead salts in solution derived from the metallic lead pipe showed them to be dangerously high. As a result of these studies all lead pipes in the Aquarium are being replaced

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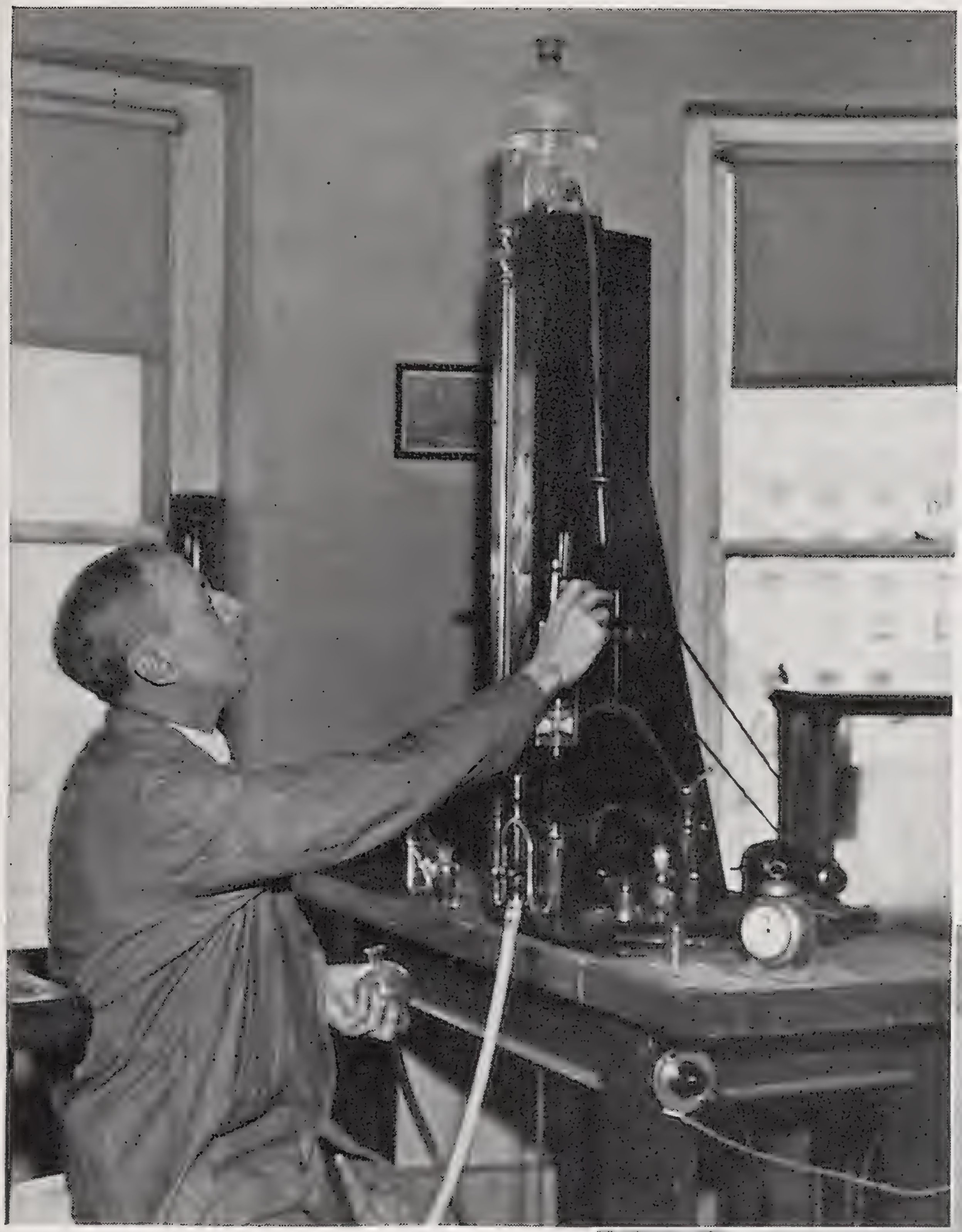
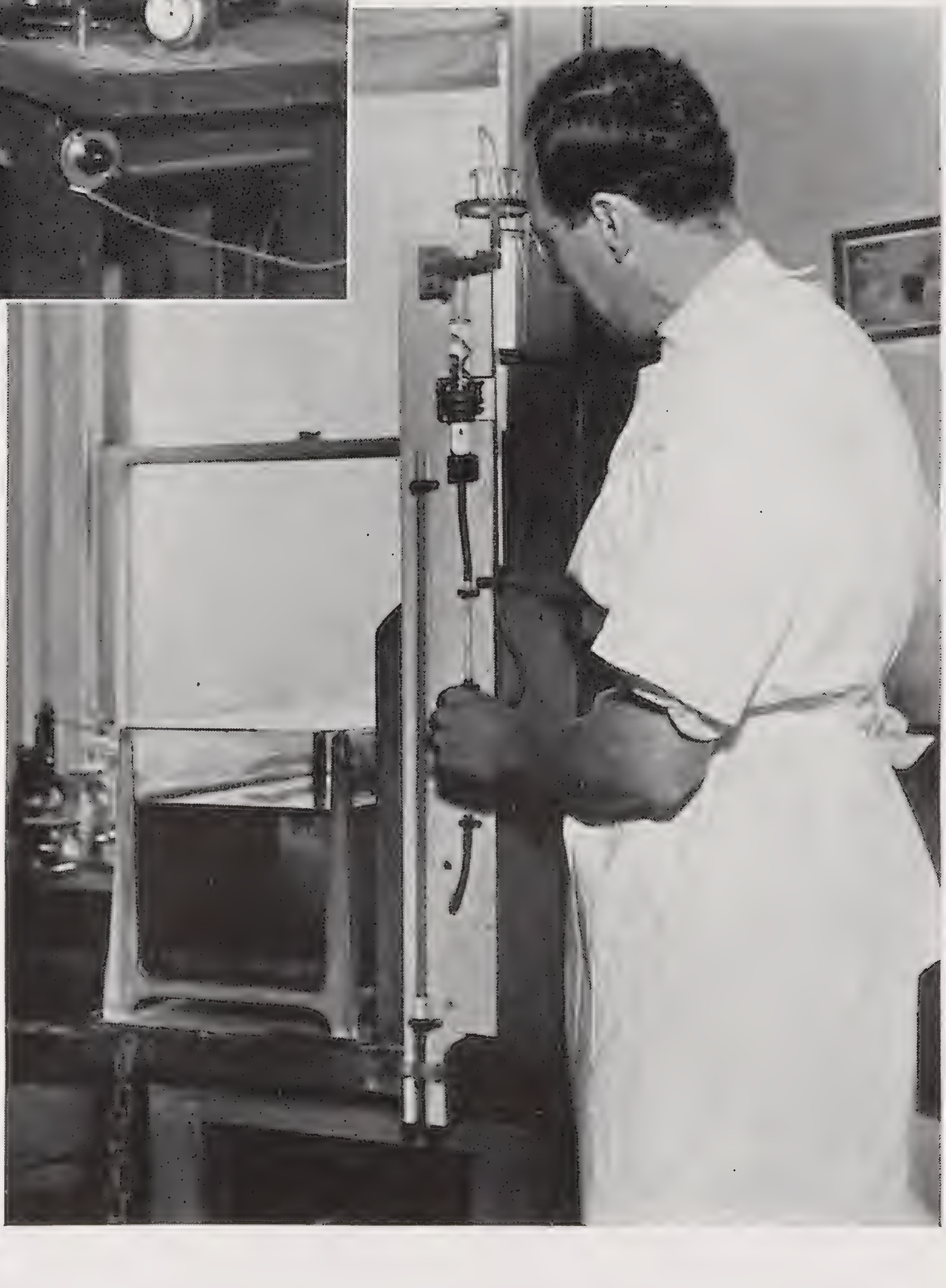
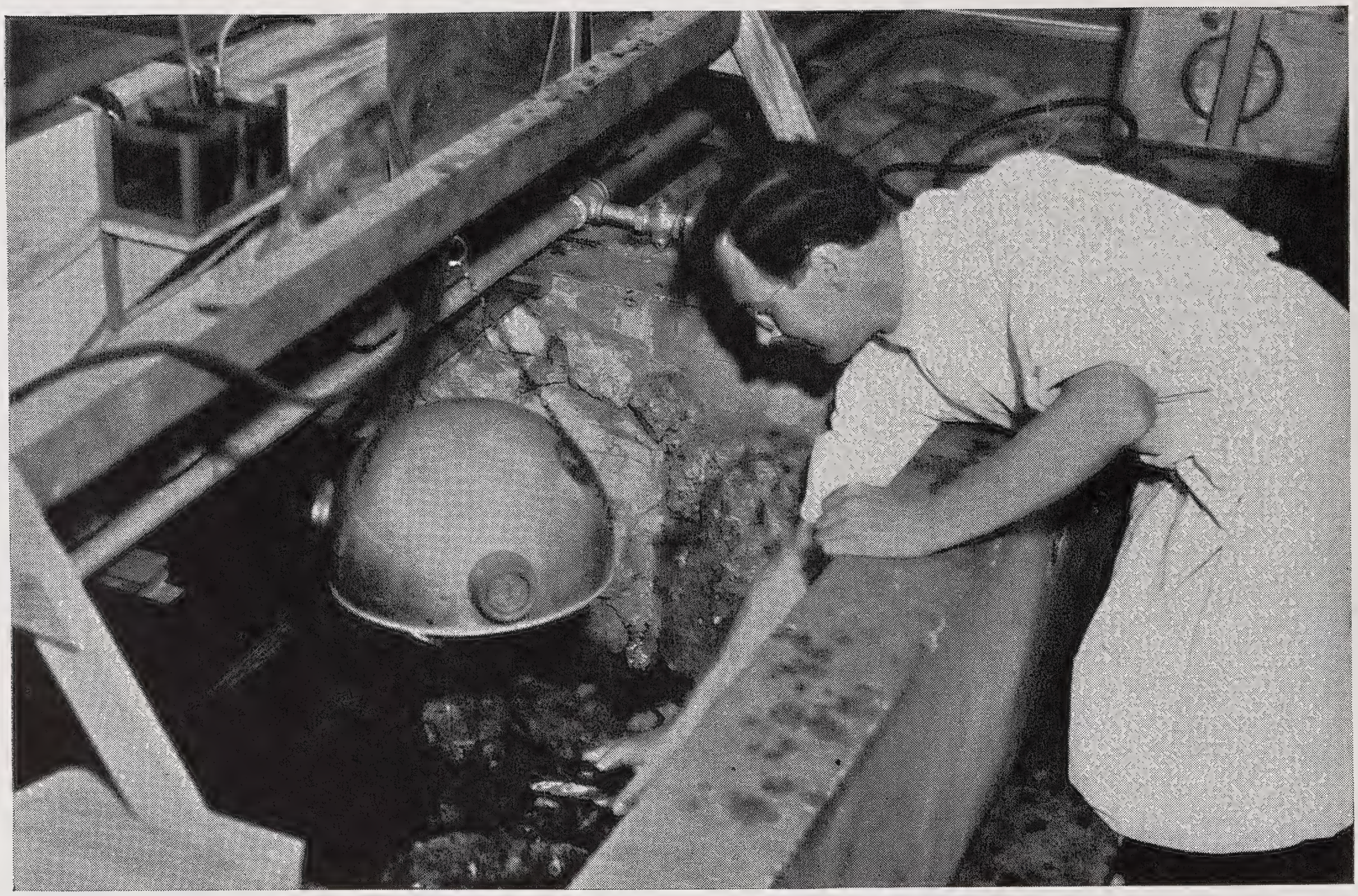
[1] *Zoologica*, Vol. IX, No. 11, 1931.
Journ. Marine Biol. Assoc., Vol. XVIII, No. 1, May, 1932.



The Van Slyke apparatus (left) was originally designed for analyses of the blood and other body fluids but it has been found of great advantage at the Aquarium in analysing sea water to determine the treatment for the stored supply.



By this delicate device the bulk of very small fishes can be determined without injuring them. They are placed in a glass tube as shown here, and the amount of water they displace is measured on an accurate scale which reads in cubic centimeters.



Artificial "sunlight" from an ultra-violet lamp has been found of great value to the health of animals that habitually bask in the sun for long periods. Certain species cannot be kept alive without it.

as rapidly as possible with non-metallic ducts.

The recently established closed fresh-water system has been entirely constructed of thoroughly tested non-metallic substances, such as concrete and hard rubber, including even the pumps. At this writing the system has not yet been placed in operation so it is impossible to comment on its full value. The establishment of this closed fresh-water system has in itself certain advantages of a chemical nature, in that it is all under the management's immediate control and can be modified in any manner by appropriate treatment. Prior to this, with the use of the city supply, the fishes were at the mercy of any fluctuations in its chemical content.

Passing from these questions, strictly concerning the chemical environment in the Aquarium, thought may be given to the control of parasites, which is another matter that requires the application of laboratory methods in order to be satisfactorily administered. It is probably fair to state that every normal fish caught in a wild state is host to at least half a dozen species of parasites. Fortunately for those who have to concern themselves with the maintenance of an aquarium, most of these are not dangerous and need cause no more concern that would a few fleas on a dog, or the variety that most humans unknowingly harbor internally, especially those of us who have travelled a bit. Another group of parasites reside in the host in an encysted state and are quite inert until they are digested out in the interior of a larger fish. These are types that are required to spend some time in different animals and cannot be transmitted from one individual to another of the same kind. They are comparable to the malarial parasite that passes from the mosquito (*Anopheles*) to man, but not from man to man. These forms are scarcely ever a problem in the Aquarium. The kinds that do give considerable concern, however, are those that may pass from fish to fish and usually live on the external parts of the animals. Such forms at times may give

In the laboratory of the Aquarium conditions of sickness and disease, of parasites and bacteria, are being studied and practical applications of the results have helped in the solution of many perplexing maintenance problems.

rise to real crises in the maintenance of an exhibit and no end of headaches to those charged with its care.

One such case that added gray hairs to certain individuals was, strange to say, a direct result of the improvement in conditions in the salt water system by use of bicarbonate of soda. The health and activity of the fishes, as previously noted, improved most markedly and, unfortunately, so did a particularly troublesome parasite (a monogenetic trematode, *Epibdella*), to say nothing of its reproductive rate. Before we fully realized just what was happening, the entire system teemed with them, and comparatively few species were found to be naturally immune. At about the time we were at our wit's end the epidemic unexpectedly subsided. Our troubles were seemingly over and we breathed more freely. However, our relief was short-lived and before long another outbreak was upon us. This went on for some time; in fact, we were forced to seek advice of parasitologists possessing technique and knowledge of these organisms that students of fishes themselves could scarcely be expected to possess. Not until the students—L. R. Kuhn, T. L. Jahn and R. F. Nigrelli—had worked out the full history of the parasite, which until then was quite unknown,[2] could we make progress in the intelligent control of this pest. Although its control is now no longer a major problem, the end of the study has not been reached. It was found that certain fishes surviving one or more epidemics became partially immune. At the present time experiments are under way looking toward the development of an artificial immunity and at this writing there are several promising leads under investigation.[3] While it is yet too soon to discuss probabilities, if this line of investigation lives up to its promise it would be nothing short of the development of a protective serum for fishes.

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[2] *Biol. Bull.*, Vol. 62.

[3] *Journ. Parasitology*, No. 5, 1934.

Since the New York Zoological Society is committed to the furthering of conservation it is appropriate that the Aquarium should concern itself with such phases as come within its sphere. To that end, Dr. Townsend has studied the distribution of whales. These, the largest animals alive today, once of great economic importance and still supporting a huge industry, are seriously threatened with extinction. By various international agreements their slaughter has been abated but there is still danger. Really suitable protection cannot be afforded until there is available a better understanding of their biology than we have today. Looking to this end Dr. Townsend, after a painstaking study of the logs of old-time whalers, has prepared a number of world charts which go far to elucidate the distribution and migration of these leviathans. This huge compilation of otherwise unavailable and valuable data has recently been published in ZOOLOGICA.[4]

Another matter with which the Director has personally concerned himself is that of the fate of the now famous giant tortoises of the Galàpagos Islands. Colonies of these huge reptiles, threatened with the fate of the carrier pigeon and the Carolina parrakeet, have been established in Florida and other suitable places.[5] Since the establishment of these controlled and guarded colonies in 1928 their growth has been remarkable, and with the approach of maturity reproduction is anticipated. These colonies make it possible to study the growth rates and other biological matters concerned with these tortoises, the former of which is already seen to be much more rapid than formerly supposed. Progress of these studies has been reported from time to time in the BULLETIN.

More nearly adjacent to the Aquarium walls are the nearby local streams. Some of the most attractive bodies of water within easy distance of the city are under the jurisdiction of the municipal Department of Water Supply. Naturally these waters are the dwelling places of various kinds of pond and stream fishes. Some of these are of distinct advantage to the proper maintenance of these bodies of water that are necessarily zealously protected because of their vital importance to the health of the citizens dependent on the supply. One species, however, has so thrived in Kensico Reservoir as to become a pest. This, the sawbelly (*Pomolobus*

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[4] Vol. 19, No. 1, April 3, 1935.

[5] *Bull. N.Y.Z.S.*, Vol. XXXIII, No. 4, 1930.

Great numbers of the elritze (Phoxinus laevis) have been imported by the Aquarium from Central Europe for the use of medical researchers, who have found it valuable in the study of certain types of human cancer.

Common catfish have spawned on exhibition during the past three seasons and have reared their young. This picture shows the eggs on the clean-swept floor of the tank.

pseudoharengus), at certains seasons foregathers near the outlet aqueduct and clogs the protective screens, and sometimes especially small ones slip through—to the great annoyance of householders, who object to free fish in their water supply.

Commissioner Herman Forster asked the Aquarium for advice and we have been cooperating with the Department of Water Supply in search of the best method of eliminating this condition. To this end a study of the habits of the sawbelly in Kensico is under way.

Since the establishment of more satisfactory conditions in the aquatic environment has been obtained in the Aquarium, attempts have been made to induce reproduction among fishes that formerly showed little, if any, such behavior. The intention has a threefold purpose: to understand better certain features of the life habits of fishes; to increase the numbers of certain species without the cost of collecting, and to furnish visitors periodically with displays of the interesting family life of the fishes that employ various types of parental care. Although this program has not been in force very long, being retarded by delays in establishing proper equipment, there have been several interesting cases that have stimulated considerable interest among a large proportion of our visitors.

For the last three seasons the common catfish has spawned on exhibition and cared for its young. The scientific results of the study involved are in preparation. The European bitterling, with its peculiar habit of depositing its eggs in the respiratory chamber of a mussel, has spawned on exhibition for two years. This fish, to which quite another interest is attached, will be considered in connection with the Aquarium's cooperation with medical institutions. Various other species, with their elaborate parental care, have interested visitors, especially among the small, tropical fishes that, generally speaking, breed with much greater facility in captivity. This is not true of all of them, however, and one of the notable events in the Aquarium routine was the repeated spawning of the strange Amazonian leaf fish which, up to that time, had not bred in aquaria. This case was discussed in a previous BULLETIN.[6]

Along with a study of these habits arose the need for a better understanding of what may be called the social life of fishes. This matter is exceedingly important in an institution where space is at a premium. Visitors frequently ask why some tanks are relatively crowded with fishes while others are comparatively empty. This, as a rule, is because of the social needs of the fishes. Some thrive in crowds, while others either pine away or wreak havoc among their tankmates in resentment of whatever in fishes corresponds to insufficient elbow room. To a certain extent there is some automatic control of population density but usually we cannot afford to let nature take its course. It was early found, for example, that a certain tank would house only a certain number of dogfish. If more were placed in it deaths would ensue until that number was reached, and this phenomenon occurred in the complete absence of fighting or disease. The dead fish showed no pathological condition and at this writing the exact cause of death is still not clear. Lest it be thought that suffocation was at the base of this, it may be mentioned that analyses for oxygen and carbon dioxide showed that they were normal. All this was independent of the rate of flow of water through the tank.

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[6] *Bull. N.Y.Z.S.*, Vol. XXXVI, No. 3, 1933.

Following these preliminary observations a more suitable fish for laboratory study was chosen—the common guppy. Population studies were carried on for three years continuously, the results of which are in preparation. A preliminary report showed, however, that the conditions were basically similar to those mentioned above. Briefly, an underpopulated tank built up to the same figure to which an overpopulation descended.[7] These figures, with slight oscillations, continued as long as the original conditions were maintained. Thus it appears that there is a definite number of fishes, differing with each species, that a given body of water under set conditions can maintain, and no amount of coaxing can change it. It may also be mentioned in this connection that the sex ratio of the fish under study always worked out to the same relationship; namely, 1 male to 2 females.

The population pressure and sex ratio in an aquarium is only one small item in the social pattern of the fishes' existence. To mention one other there is, as in human society, the direct relationship of individual to individual. Certain features of this have also been studied. What, for example, causes one species persistently to form in schools and others to fight just as persistently with all comers? There is still much to be learned about the "social contacts" of fishes and while superficially they may seem to be of academic interest only, actually they are charged with significance in the proper keeping of aquarium fishes in suitable environments. What suppresses the fighting instinct and what releases the schooling habit? In some fishes, for example certain sunfish which have been studied at the Aquarium, schooling only occurs below a certain definite temperature and then only in the presence of a slight current. The form of the school is mechanically arranged by the current. Its absence prevents a formation, as does a higher temperature. Under the influence of high but not suffocating amounts of carbon dioxide, certain tropical fishes much given to fighting will cease hostilities.

A discussion of these matters would carry us into a highly technical exposition, but the above may serve to suggest some of the problems involved and their significance to aquarium management.

Cooperation with other institutions has been long and varied but merely cataloguing instances would hardly make interesting reading. Preserved material of value usually finds its way into the collections of the American Museum of Natural History, with which institution such cooperation has been close. Dr. W. K. Gregory, Curator-in-Chief of the Department of Fishes of that institution, contributes an article in this issue indicative of the usefulness of cooperation between institutions respectively devoted to the study of living and preserved material. Cooperative activities have included organizations such as the United States Bureau of Fisheries, the United States National Museum, the Bingham Oceanographic Foundation of Yale University, as well as a host of minor contacts with other museums, aquariums, hospitals, and so on.

Perhaps the most interesting cooperative efforts of recent years have been with medical institutions. Chief among these has been the biological tests for which fishes have been found valuable. The most notable of these involved two species, both native to Europe, and their importation to a considerable extent was carried on by the Aquarium. One of them, the elritze (*Phoxinus laevis*), has proved valuable in the determination of certain types of cancer (melanoma) in its very early stages, when diagnosis by other means is not readily applicable. Dr. R. S. Ferguson of Memorial Hospital, New York City, instigated these investigations in America, which have since been carried on chiefly by him and Dr. Charles C. Lund of Collis P. Huntington Memorial Hospital of Boston, Massachusetts.

The other fish is the bitterling, *Rhodeus amarus*. This amazing little creature deposits its eggs in the gill chambers of a fresh-water mussel where they incubate and on hatching escape to the outside world. The deposition of the eggs is possible because of the long ovipositor of the female, a slender tube that is inserted into the mussel. The reactions of this tube in regard to lengthening have been found to be of value to medical men in determining pregnancy, by means of a suitable procedure. Although not native to North America, it is well able to reproduce in mussels of American species, which it has done successfully in the Aquarium on various occasions.

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[7] *Copeia*, No. 3, 1932.

Recalling studies of malignant growths and fishes, it may be mentioned that Dr. Myron Gordon of Cornell University studied the inheritance of a type of melanosis in the platy fish, with much significance. One of his strains in the platy, in which the genetics are not yet thoroughly understood, is now established in the Aquarium laboratory under the study of M. Sobol of New York University. As might be gathered from this remark, fishes themselves have their own troubles in the matter of pathological growths. Dr. George M. Smith, of the Department of Anatomy, Yale Medical School, New Haven, Connecticut, has been making a survey of such manifestations that put in their appearance at the Aquarium. The collection of material he has already accumulated suggests a variety of interesting approaches that are under study. His studies on the lateral line of fishes are discussed by him in an accompanying article.

A female bitterling, showing the elongate ovipositor by means of which eggs are deposited in fresh-water mussels.

The structure of the eyes of flying fish is of particular interest because of their activity both in and out of water. A study of their anatomy is being undertaken by Dr. E. B. Gresser. This study is really a part of a much larger program that is building up a tremendous library of microscopic slides of fish eyes, both normal and pathological, for the department of ophthalmology of the School of Medicine of New York University. Some of the more general aspects of fish vision are herein discussed by Dr. Gresser, on the basis of his research.

The studies of Dr. Homer Smith and Dr. W. Antopol have previously been touched upon. Dr. Smith has contributed an article discussing the evolutionary aspects of his studies on the fish kidney, which is presented in this Bulletin.

One peculiar item was initiated by an attempt to understand better the details of some of the biological interchanges occurring in a so-called "balanced aquarium." This led to the finding of a bacteriophage in the waters of certain long-standing aquaria and served to explain some phenomena involving the failure of decomposable matter to decay rapidly. This prompted C. W. Coates to wonder about the possible medical aspects of such a bacteriophage. What it led to and how the publicity finally became a source of considerable annoyance to the Aquarium is discussed by him under the title, "The Genesis of a Front Page Story."

Of especial interest to the writer, but having no connection with medicine, was the recent work of J. E. Harris of the University of Cambridge, England, at the Aquarium. Mr. Harris, studying the physics of elements of the locomotion of fishes, touched an old-time interest that seems to have relatively little attraction for biologists today, although this subject is still charged with a large number of interesting possibilities.

This bare outline of some of the laboratory's activities and cooperation with other institutions in scientific research will give the general reader some insight into the multifarious details that must be considered in order to take advantage of possibilities that an institution such as the Aquarium presents. Such work is necessary to keep it a vital organization, constantly straining to increase biological knowledge and enlarge its value to the public.

The Evolution of the Kidney

Homer W. Smith
Professor of Physiology, College of Medicine
New York University

It is apparent to every one that living organisms are exposed, at one time or another, to extreme variations in the environmental conditions under which they live. In contrast to this variability in the *milieu extérieur,* Claude Bernard, some fifty years ago, emphasized the remarkable constancy of composition of the blood which, circulating throughout the body, actually bathes the delicate nerve cells, muscles, glands, etc. Bernard aptly described this vital fluid as the *milieu intérieur.* In the intervening years his thesis has assumed an increased significance for we know that the *milieu intérieur* is indeed so constant in its composition that the physiologist is often taxed to measure such changes as mean the difference between life and death.

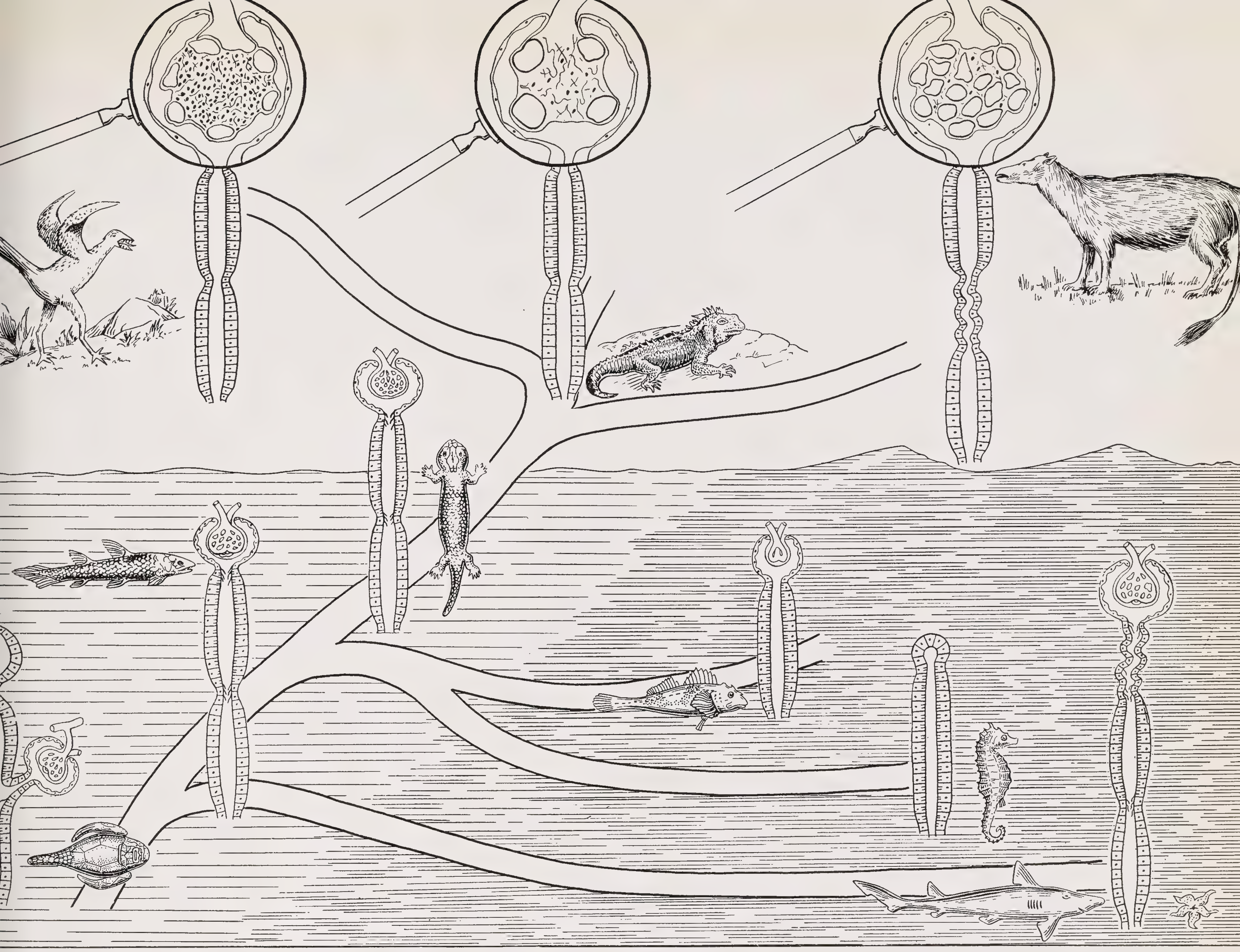
There is no place in the animal kingdom where the *constancy* of the *milieu intérieur* contrasts so greatly with the *inconstancy* of the *milieu extérieur* as in the fishes, for these animals live in a habitat ranging in composition from the purest mountain streams to sea water containing large amounts of numerous salts.

A full statement of the delicate adjustments involved when a fresh water fish migrates into salt water would lead us into an extended discussion of the physical-chemical properties of the blood and the physiology of the kidney. And at once we would be tempted to fit our knowledge of the fishes into the larger frame comprising our knowledge of other animals, particularly of man, for the problem of the regulation of the composition of the blood, whether in man or fish, is essentially the same. We must be content with sketching in the rougher outlines.

The human kidney is an organ of considerable structural complexity yet this complexity suggests little of the involved chemical operations that it is carrying on, minute by minute. The blood is repurified many times a day, and in this process of repurification a great many substances are chemically sorted from each other. Some substances are selected for retention in the body, while others, foreign invaders or waste products, are cast aside for excretion. A complete count has never been made but it is probable that at least fifty substances are present in the blood that are valuable to the body and must be saved; how many waste products there are, how many foreign substances that gain access to the body through the food, there is no way of knowing. The intricate operations of weighing, dissolving, conjugating, dissociating, repurifying, etc., that go on in the research laboratories of a great chemical manufacturing plant appear to be simple compared to the operations that go on all the time in the kidney. And the net result of all this—in line with Bernard's thesis—is that those substances retained in the blood are maintained there within remarkably narrow limits of concentration.

To take just one example, water: if we contrast a man, a reptile and a fresh water fish, we see that they live under very different conditions especially with respect to the extent to which water is available to them. Yet in each the intake and output of water is perfectly balanced and the kidneys maintain the water content of the blood not only at a constant, but at a nearly identical level.

The microscopic, functional unit of the human kidney is similar to that observed in other mammals, the typical structure of which is illustrated diagrammatically in the upper right hand corner of the figure on page 121. This nephron as it is called, is divisible into four distinct parts: (a) the glomerulus, an elaborate tuft of capillaries whose walls are so thin that through them water and dissolved substances can be filtered from the blood at a rapid rate; attached to this glomerular filter is a tubule which in



In a highly simplified way these diagrams show the evolution of the functional unit of the kidney. They illustrate only the more outstanding differences in the structure of the kidney centering around the maintenance of water equilibrium.

turn is divided into three parts, (b) a proximal portion, (c) an intermediate segment commonly referred to as the loop of Henle, and (d) a distal portion. In the kidney these tubules are actually bent like hair pins and intricately convoluted, but these details are of secondary importance and have been omitted in the diagram. In the two human kidneys there are about 9,000,000 such nephric units.

We know that the process of urine formation takes place in this manner: under the hydrostatic pressure of the blood a constant stream of protein-free plasma is filtered through each glomerulus and started on its way down the adjoining tubule. Valuable substances such as salts and glucose are reabsorbed by the tubule cells and returned to the blood, while waste products are left behind in the lumen to pass into the urine. In addition to this process of *filtration* and *reabsorption,* the tubule cells take additional waste products directly from the blood and *secrete* them into the tubular urine. About 180 liters of fluid are filtered through the glomeruli of the two kidneys of man per day, of which about 179 liters are reabsorbed by the tubules, leaving 1 liter to be discarded from the body. There are only about 3.5 liters of fluid circulating in the blood at any time, so that it follows that this fluid is purified by filtration and reabsorption something like fifty times per day.

Not only have investigations on the kidneys of the fishes and the Amphibia contributed enormously to our interpretation of the operations by which the human kidney carries out its complex duties, but qualitative and quantitative methods for measuring some of the processes that go on in the normal and diseased human kidney have come almost directly from such studies. And one of the most interesting ways in which the fish kidney has contributed to the physiology of the human kidney is by the light it has thrown upon the evolution of this organ.

The story of the evolution of the vertebrates is essentially a story of adaptation to water, or lack of it. If we consider the Amphibia as aquatic animals, and date the beginning of true terrestrial life from the appearance of the reptiles at the close of the Triassic, then for 300 million out of the 500 million years, or for 3/5 of their total evolutionary history, our ancestors have lived in, or been bound to, water. The outstanding events in the evolution of the kidney occurred in what we may call the ancient and medieval periods of biological history while we (the vertebrates) were still aquatic forms.

There is good reason to believe that the first definitive fishes were evolved in the fresh waters of the Cambrian or Silurian continents. The ancestry of the protovertebrates is still obscure, but we may infer from the data of comparative anatomy that they had a much simpler kidney than is observed in any living form; it probably consisted of a series of bilateral segmentally arranged tubules draining the primitive body cavity and opening into this cavity by nephrostomes. These rental tubules functioned principally, no doubt, by picking up substances from the blood and transporting them directly, i.e., secreting them, into their lumina, from which they drained to the exterior of the body. Thus we may look upon the process of *secretion* in the human kidney as a legacy from our marine invertebrate days.

The toadfish has a purely tubular kidney. Experiments on it have aided in the studies of the renal function in man.

When this protovertebrate took up residence in fresh water, its blood and tissues, bearing the impress of its marine environment, were rich in salts; and in the new environment these salts, by their osmotic pressure, drew water into the body not only through the intestinal tract and respiratory membranes, but also through the skin. The organism had to resist this constant influx of water by excreting it some place, lest it swell up to the point of dissolution. No better means could be devised for excreting this water than to let the heart pump it out of the body through a suitable filtering bed. This filtering bed was devised by the simple process of bringing a tuft of capillaries into close juxtaposition with the already existing tubules. Thus the pattern of the first glomerulus was laid down, something in the manner indicated diagrammatically in the left hand corner of the figure, in a fresh water habitat, and in response to the need to excrete large quantities of water. The addition of the new high pressure filtering system supplanted, because of its efficiency, the primitive nephrostomes opening into the body cavity so that for the most part these have tended to disappear.

With this invention of the glomerulus there was entailed the need for adding new tubules, or modifying the old ones, so that valuable substances, necessarily passing through the filter along with the water, could be conserved for the body. This conservation had to be effected by a process of reabsorption, the valuable substances being withdrawn from the filtrate by the tubule cells as the filtrate moved along on its way to the bladder. The pattern of the reabsorptive tubule must have followed very closely upon the original invention of filtration, and the new tubules were probably but slight modifications in structure and function of the old ones, for Nature usually works by putting old things to a new use; her inventions are not often highly original, and in adding the physiological process of reabsorption to the kidney, she was simply turning the old process of secretion round about—secreting from the tubular lumen into the blood instead of from the blood into the tubular lumen.

Thus, by the time evolution had produced the primitive fresh water fishes, the kidney operated by the circuitous method of glomerular *filtration* and tubular *reabsorption,* with tubular *secretion* carried on as a vestige of more primitive days.

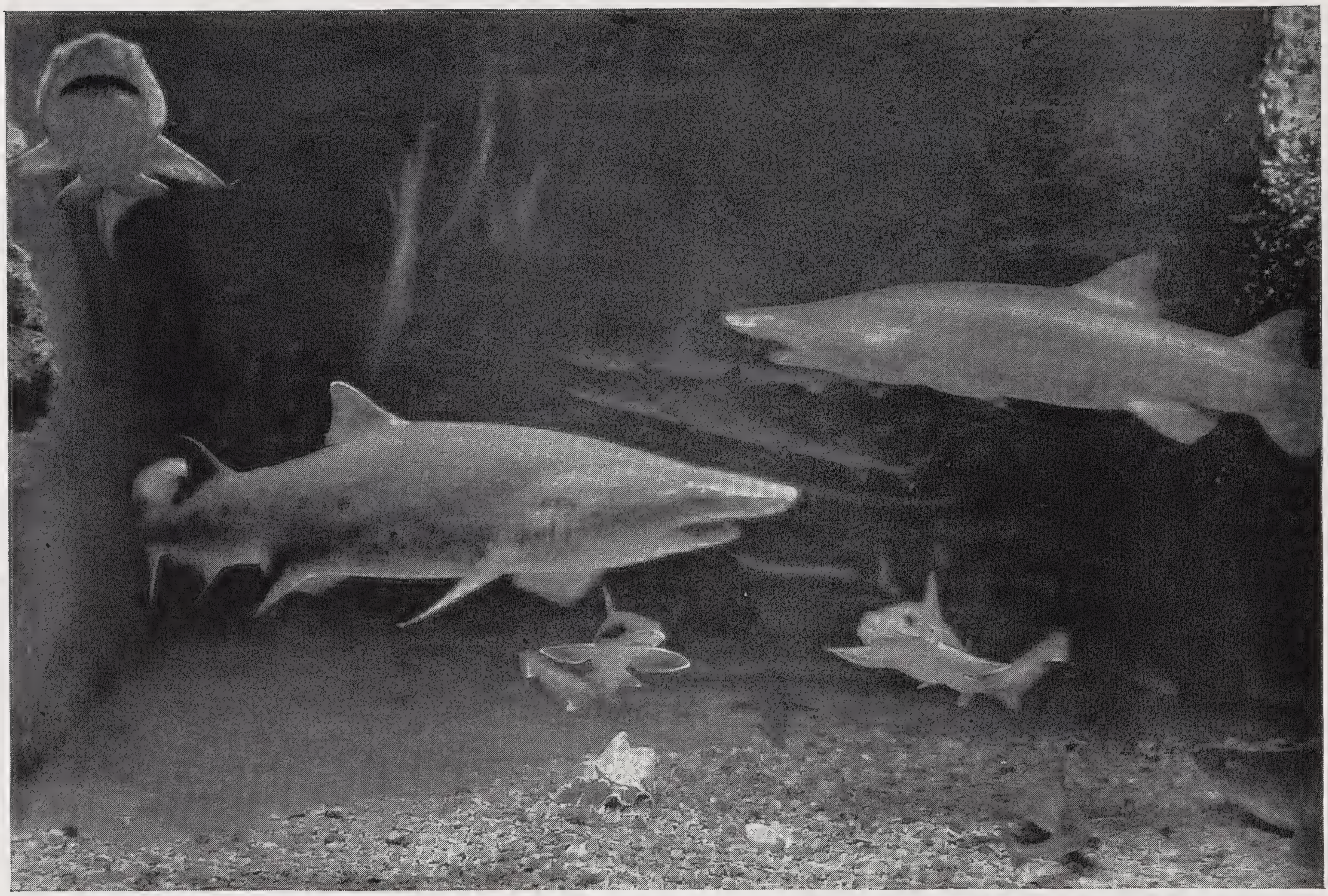
So long as the vertebrates could remain peacefully in fresh water, or live in intimate relation to it, as do the Amphibia, this filtration-reabsorption system proved highly efficient and tended to persist, and even to be improved upon. But geologic upheavals made this very difficult. The earth is not a hard ball of solid rock, but a relatively thin shell of granite resting on soft basalt, which in turn envelopes a molten core of iron and nickel. This combination is not conducive to geophysical stability; during geologic history the earth has shrunk in its diameter at least 200, and perhaps 400, miles; periods of abrupt internal heating have alternated with longer periods of cooling, and the granitic crust has repeatedly heaved outwards to contract again, folding and wrinkling like a drying apple. Again and again the continents have been wrinkled into mountain chains and all but drained of their fresh water rivers and lakes, or vast areas of land have been submerged below the sea; the temperature of the earth's surface has varied between the extremes of tropic aridity and arctic glaciation, and through all these vicissitudes the vertebrates have had to live where best they could. In successive revolutions, as the continental waters were drained away, or dried up into foul and irrespirable swamps, some of the fishes were driven back into the sea, while others were driven to take up aerial respiration, as it is observed in the lungfishes of today. Some of the Devonian air-breathers, who had stout paddle-like fins, crawled out upon the land and founded the terrestrial amphibian stock. After some 200 million years of this uncertainty, widespread aridity placed such a premium upon stable aquatic life that some of the vertebrates broke the ties that bound them to fresh water entirely, and the reptiles were evolved. From these reptiles there came the birds which, as someone has said, are more reptilian than avian. And at a later time, possibly as a concomitant of the appearance of marked seasonal changes in climate, there came the mammals, warm-blooded, and bearing their young alive.

Now this history of the restless earth must be taken into account if we are to understand the architecture and the function of the kidney in various animals.

With the secondary assumption of a marine habitat on the part of the fishes, the circumstances that had given rise to the glomerulus were reversed. Where in fresh water the animal had been osmotically superior to its environment, and therefore in a position to absorb all the water it needed, and in fact more than it wanted, in the sea it found itself in a salt solution having a higher osmotic pressure than its blood; with the reversal in osmotic gradient it tended to lose water to its environment all the time. It was faced with the need for conserving every bit of water that it could get. The glomerular filter, at least with its original set-up of tubules, could no longer be used economically.

Several things might happen—in fact, have happened. Among the majority of marine fishes we find the glomeruli reduced in size and poorly vascularized, and normally operating under some as yet undetermined physiological inhibition. In extreme cases we find the glomeruli disappearing entirely, the animal being left with a purely tubular kidney, of the type observed in the toadfish, goosefish, sea horse, pipe fish and certain deep sea fishes. But short of this result all degrees of glomerular degradation are observed. This is one solution to the difficulty: stop the loss of water entailed in filtration by closing up the glomeruli, or by ultimately throwing them away entirely. (See the sea horse in the right of the figure.)

But there are more tricks in Nature's bag than just putting rabbits in and taking them out again: not infrequently she turns the rabbit into something entirely new. The lowest class of fishes, known as the elasmobranchs (the sharks, rays and skates), have gotten around the osmotic



Sharks (above), skates and rays have found a way out of the osmotic difficulties of living in salt water by the simple renal invention of reabsorbing in their blood stream upwards of 2 per cent. of urea.

difficulty of living in salt water by a renal invention as surprisingly simple as it is unique. Rather than remain osmotically inferior to their environment, and therefore at a constant disadvantage in respect to water equilibrium, they have resorted to reabsorbing from the glomerular filtrate the chief product of protein metabolism, urea, returning this otherwise inert waste product to the blood. By this conservation of urea they raise the osmotic pressure of their blood to a level above that of their environment, so that in the end they find themselves back where their fresh water Silurian ancestors were, with a *milieu intérieur* osmotically superior to their *milieu extérieur.* There is a special tubular segment between the glomerulus and the proximal tubule in the Elasmobranchii that is thought to be concerned with this process. (See the shark in the extreme lower right of the figure.) Thus by a modification of the principle of reabsorption, the primitive filtration mechanism continues to be utilized to good advantage by the elasmobranch fishes, in spite of their long residence in the sea.

In the arid-living reptiles the need for water conservation is even greater than in the marine fishes. The glomeruli have not disappeared, however, though they appear to be headed in that direction; the glomerular tuft is reduced in size, poorly vascularized and contains a dense core of inert connective tissue replacing the original delicate filtering-bed, as though these animals were willing—nay, anxious—to let that old filtering-bed clog up. In the birds a similar anatomical situation obtains; the glomeruli are inferior in structure, due in part, perhaps, to the fact that they inherited poor glomeruli from their reptilian ancestors, but glomerular function is relatively greater because, being warm-blooded, they have a much greater circulation rate.

Why the glomeruli have not disappeared entirely in the reptiles and birds, is a little puzzling. There is a clue to the answer, perhaps, in their metabolism. Protein nitrogen is degraded not to urea, as in the other animals, but to uric acid. Where urea is a highly soluble substance, uric acid is highly insoluble. Uric acid is apparently secreted in very high concentrations into the lumina of the tubules of the reptiles and birds—probably in supersaturated solution—whence it is washed down by a slow and relatively feeble stream of water from the glomeruli to the collecting ducts of the kidney, and thence carried by the ureters to the cloaca. Here the uric acid precipitates out of solution, leaving the water free for reabsorption, and the uric acid is excreted as an almost dry paste. Thus almost no water at all is required to excrete the chief nitrogenous waste product from the body in these animals. If we accept this view, that the uric acid metabolism of the birds and reptiles is an adaptation to arid terrestrial life, then we may believe that this physiological habit has left these animals in a position where they can use a low-grade filtration process advantageously to flush the tubules; and it would seem that, like the elasmobranch fishes, they have by a secondary adaptation—this time by overhauling their protein combustion—incorporated the primitive water-excreting mechanism into a filtration-reabsorption system in which they can, so to speak, excrete water at the glomerulus, and yet keep it, too.

It is in the mammals, however, that tubular modification is carried to the most advanced degree. The mammals came from a primitive reptilian stem and, except for a few definitely aquatic forms, the danger of water shortage and the need for water conservation is as great in them as in other land-living forms. The mammals have perfected the first unique renal invention since the days of the fishes; between the ancient proximal and distal segments of the tubule they have introduced a new segment, known as the loop of Henle. This appears to be the place where the greater part of the filtered water is reabsorbed. If, in the single matter of capacity for doing osmotic work, the mammalian kidney were likened to a modern locomotive, then the kidney of the lower animals might be likened to Watts' tea-kettle with its feebly bumping lid. It is probably because of this relatively great efficiency in respect to water reabsorption, coupled with the increased circulation of blood accompanying the warm-blooded state, that in man the filtration-reabsorption process reaches the large figure already cited.

It is thus, we believe, that the circuitous method for the manufacture of urine as we observe it in man has come about. The process of filtration dates from the origin of the vertebrates when their chief morphological and functional characters were laid down in the Silurian or perhaps the Cambrian fresh water rivers; the reabsorption of valuable substances, such as salt and glucose, dates from this same era, for reabsorption came about as a corollary to filtration. The process of tubular secretion goes back, no doubt, to some marine invertebrate, to whatever remote stock sired the vertebrates. The reabsorption of water against osmotic pressure, attributed to the loop of Henle, is the only original patent to which the mammals can lay claim, or at any rate the only one that they have perfected to any great degree.

It would appear, from this résumé of its evolution, that the human kidney was not created *de novo* in order that it might manufacture urine at a specified rate and of a specified water content, or even to maintain the blood in some specified composition such as would be implied in Claude Bernard's thesis of the constancy of the vital *milieu intérieur;* rather the kidney manufactures urine and maintains the blood in a particular composition because it has the functional architecture that it has; and it owes that architecture to the fact that the earth is a cooling ball with a fragile crust, to the geological revolutions that have raised and lowered continents, to the climatic changes that have driven the mutant vertebrates from the sea into the continental rivers, into dessicating swamps and at last out upon the dry land where, if they could get water at all, it was only occasionally.

The migration from fresh water to salt water, or from fresh water to the land, has entailed modifications not only in the structure and function of the kidney, but changes in blood supply and nervous regulation as well, and in the relations of this organ to other organs of the body, particularly the endocrine glands. There seems to be no end to the physiological questions involved, and no hope of setting a date at which they can all be worked out. But there is no place where more interesting problems are presented than among the fishes, which include both primitive and highly specialized forms.

The mud skipper (Periophthalmus koelreuteri Pallas) is a fish that spends much time out of water and although its eye is not divided, it can see accurately both in and out of water.

The Eyes of Fishes

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THE superficial similarity between types of vertebrate eyes compels a study of each type in order to understand the basis of the functioning of the human eye. At times the only way of obtaining a clear understanding of certain processes in the human eye is to experiment and study the analogous conditions in other vertebrates or even in lower forms.

In order better to understand the human eye we found it necessary to obtain the cooperation of the New York Aquarium in the supplying of piscian eyes, and to obtain information from those working in closely related fields. To our great interest, problems in vision and morphology were so often suggested by the various members of the Aquarium, that at times one felt that a more complete and satisfying lifetime could be spent within the walls of this institution, just studying fish eyes. Some of the interesting problems suggested and which still have to be elucidated, have to do with the vision of flying fish both in and out of water, the vision of fish in clear, shallow water where the surface of the water acts as a mirror, and certain structures of the eyes that probably have to do with shielding them from the sun's rays.

The structure of the eyes of fishes varies considerably between groups, although their shape is fairly uniform. The eyeballs, in general, are rarely spherical, as the cornea is flattened. Because of the medium in which they live, the refracting element of the cornea is neutralized by the surrounding water, which has the same index of refraction. Hence, the cornea has become flat, both because the lens refracting effect would be superfluous and because a projecting curved surface would be an additional source of injury. Other than in the sharks, the eyes of fishes are not protected by eyelids. Even in this group the lids are not quite effective, although they have an additional nictitating membrane or third lid of weak power.

The greatest protection of the eyes of fishes from outside injury is the flat cornea that allows the surface or side of the fish to be streamlined. Further protection to the eyeball is given by the cartilaginous or bony structures found in the outer covering of the globe and by the formation of the bony or cartilaginous cranial cup in which the eye is set. However, there are many exceptions, such as in the young or larval forms of very deep sea fishes, as has been described by Dr. William Beebe. In these fishes, *Idiacanthus,* Dr. Beebe has shown that before the metamorphosis into the adult form the eyes are carried at the ends of stalks. These young fishes were formerly known under the name of *Stylophthalmus*. The star-gazer fish has its eyes on the top of its body, as do the flounders. In *Periophthalmus* and *Anableps* the eyes protrude beyond the body surface, being on the lateral side but raised above the body level.

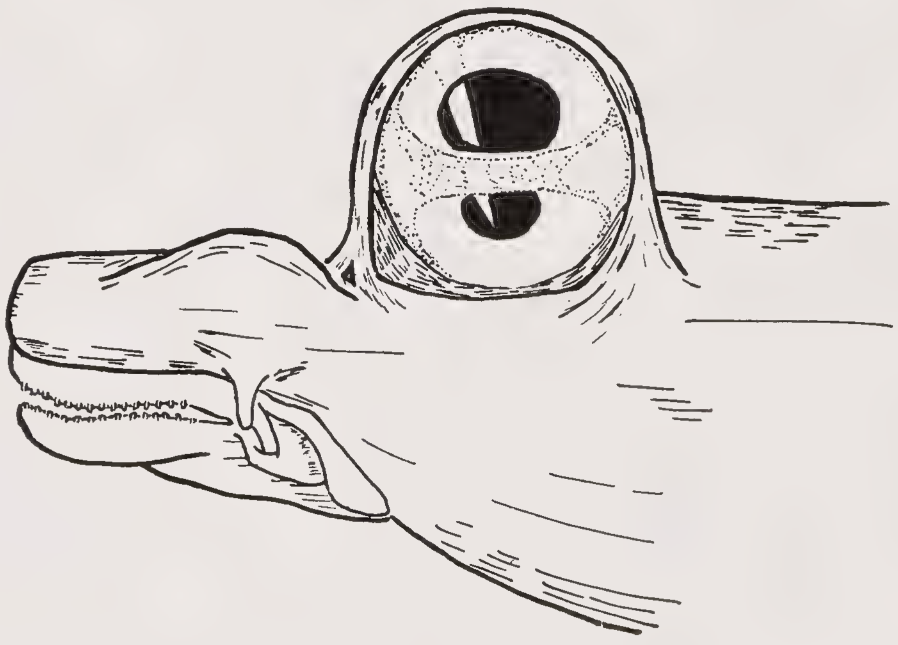
In general it can be said that the back of the fish eye is elliptical, with a flattened exterior (corneal) surface. Again, there are interesting exceptions, for although we expect an eye to be built like a camera and have a boxlike compartment with a focussing lens in its system, there are eyes built like telescopes, as in the deep sea fish *Odontostomus hyalinus*, and eyes that are divided into two, as in the South American fish *Anableps anableps*. In the latter, because the fish swims on the surface of the sea, this formation of the eye allows satisfactory vision above as well as under water.

There is a great variety in the colors of the fish eye, which results from the coloration of the iris. In most fishes that inhabit the northern and southern oceans the irides have gradations of gray and silver, from the deposit of guanine crystals. Among the tropical forms of fishes there are irides that have brilliant reds, greens, purples and other colors produced by oil droplets in the iris tissues. The patterns of these irides usually follow the body pattern.

The iris of most fishes is immobile or but slightly active. Where there is much light, especially reflected light, some mechanism must be present to shut out the superfluous rays. In the human being this is accomplished by the contraction of the iris to small size. In fishes, however, this is to a large extent unnecessary, as the water absorbs a great deal of light. In tropical fish, especially those that inhabit shallow waters with clear sandy bottoms, there has developed on the iris a small fold of tissue that acts as an umbrella or shield and which has been called the operculum or umbraculum. In some species this part of the iris can be extended outward as far as the cornea and thus shield the pupil. The purpose of the iris is to allow but a certain part of the light rays to enter the eye. The pupillary aperture in most fishes is relatively large so as to afford a more efficient optical mechanism. Probably the fixed iris with a large opening has been developed in response to the fairly murky environment in which most fishes live.

The interior of the eye is filled with a clear substance called the vitreous humor, which differs in no respect from that in other vertebrates. The purpose of this material is to maintain the size and shape of the eye and to transmit the light rays without loss.

On the outer side of the vitreous is the retina, the part of the eye that is stimulated by light rays and which transforms the physical light rays into nervous energy. The retina is a part of the brain which has outpocketed in the embryo and become covered by tissue that eventually developed into the choroid and sclera. The retina is composed of peripheral nerve endings that are so specialized that an ultimate understanding of their structure and nature is still incomplete. It is in this part that the rods and cones are found. These elements are the sensory nerve endings that have to do with both color vision and perceptive vision. There is no question that fish see, but to what extent is still not completely known. Most investigators feel that fish are near-sighted, or myopic, and color blind. On the other hand, there are no end of expert trout fishermen who have experimented with differently colored and formed flies and swear that fish have fairly keen color vision.



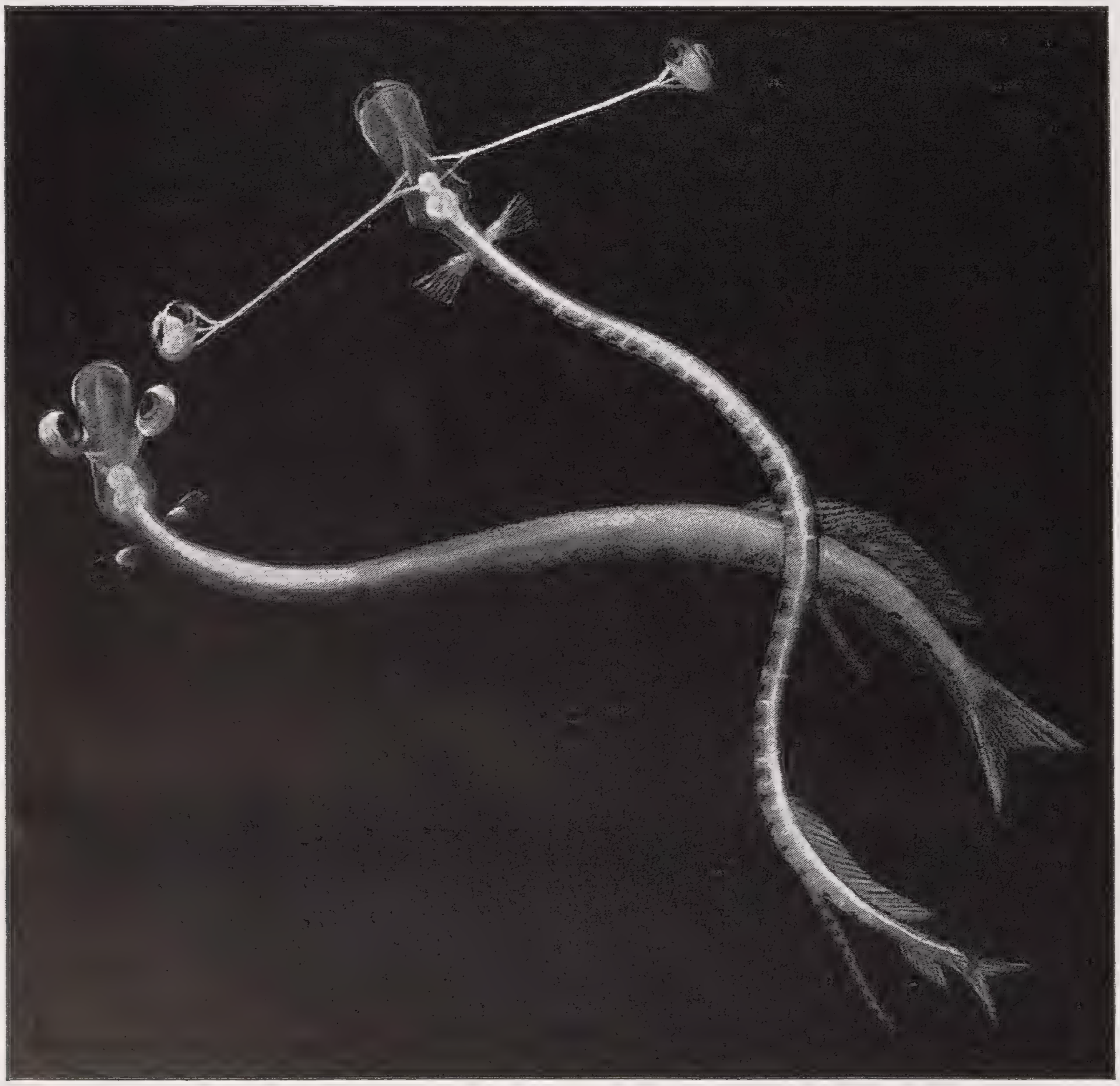
The four-eyed fish (Anableps) actually has a double eye for vision in the air and under the water.

There are many curious ways in which fish have improved their fields of vision. In the flounders one eye would have been entirely lost or so degenerated as to be useless if, when they change from the upright symmetrical form to the flat form, one eye did not rotate around. In this peculiar migration one eye rotates through an arc of 90 degrees until it assumes its permanent location alongside its fellow.

As was mentioned above, there are some young forms of deep sea fish that carry their eyes at the end of stalks so that they encompass a greater area of vision. Some types of fish illuminate their surroundings by means of small, phosphorescent light organs to see better.

Odontostomus hyalinus, a member of the order Isospondyli, has a telescopic eye on the sides of which little windows (corneas) are placed so as to increase the field of observation. This, no doubt, was also a biological adaptation to receive as much light as possible in the poorly illuminated depths of the sea and to increase its lateral fields.

The blood supply in the eyes of fishes differs considerably from that of most other vertebrates. In the bony fishes, surrounding the optic nerve there is a horseshoe-shaped mass of blood vessels called the choroidal gland. In addition to supplying the necessary nourishment to sensitive parts it also plays a part in maintaining the equilibrium between the intraocular fluids. This same type of fish has a process containing some muscle fibers that passes from the choroidal gland and pierces the internal layer, ending in a sac-like enlargement which is attached to the crystalline lens. This process is called the Processus falciformis, from its shape, and the sac at its end is called the Campanulla Halleri. This organ can retract the lens and so alter the accommodation of the eye. Other fishes have a choroidal layer of blood vessels between the retina and outer covering that supplies the necessary blood to the interior eye structures.



The eyes of deep-sea fishes show some curious specializations—such as those of the larval forms of Idiacanthus, which are carried on long stalks. (From a drawing by Else Bostelmann.)

The ability or power to alter the acuity of vision as humans do by accommodation is not so highly developed in fishes and is brought about by a different mechanism. In humans there is a definite muscle that allows a change in the shape of the lens which alters the dioptric powers of the eye system. In fishes this is done by such a mechanism as described above, which displaces the lens from position to position, as in a camera.

The outer covering of the eyes, the sclera, usually has a plate of cartilage in its makeup to give strength to the globe. In the elasmobranchs this cartilage is well developed and in the teleosts there is in addition some true bone formation. In the sharks and some rays there is a stalk of cartilage springing from the orbital wall and in which the eyeball rests.

The optic nerve pierces the eye posteriorly or to one side of the globe and passes through all the layers until it reaches the retina.

Although most of the fishes have six external muscles to rotate the eyes through the various planes, there is little excursion of movement, as those who have watched fish know.

Winged Sharks

William K. Gregory
Fellow of the New York Zoological Society

If ever the reader has dreamed of flying and of looking down on an admiring populace as he flapped his wings serenely, he may in some measure recapture the joy of that dream by watching the cow-nosed ray in the Aquarium as it flies leisurely out of the haze in the background and glides gently down to the white sand. Even the swirling movement of the wings and the slight thud at the end of each beat have a dream-like quality.

However, it is now near mid-day and we are not at the Aquarium to dream dreams but to guide a group of students on a tour of comparative studies on the body-forms and locomotion of fishes. So while we are here, let us start a discussion of flying under water, especially as it is practised by the cow-nosed eagle-ray (*Rhinoptera quadriloba* Le Sueur). There! Look at him now! He is moving again. A couple of flaps with those great triangular wings is enough to launch him into the "air". See how he jumps forward on the upstroke but is checked momentarily on the downstroke.

But why should he jump forward on the upstroke?

When the wings are raised they throw the water upward, backward and inward and the reaction pushes the body forward. In fact, the eagle-ray's methods suggest a bird flying upside down, in which case the propulsive stroke would be upward and the recovery stroke downward. But in the eagle-ray there must also be some propulsive value in the downstroke, because in this position the wings push the water outward and backward and the reaction would push each side inward and forward. When the flying eagle-ray is viewed from the rear, his wings suggest a pair of immense, slightly crescentic fish tails fastened obliquely along the sides of the body, and no doubt they wedge the body forward between them.

But what causes the slight check in speed?

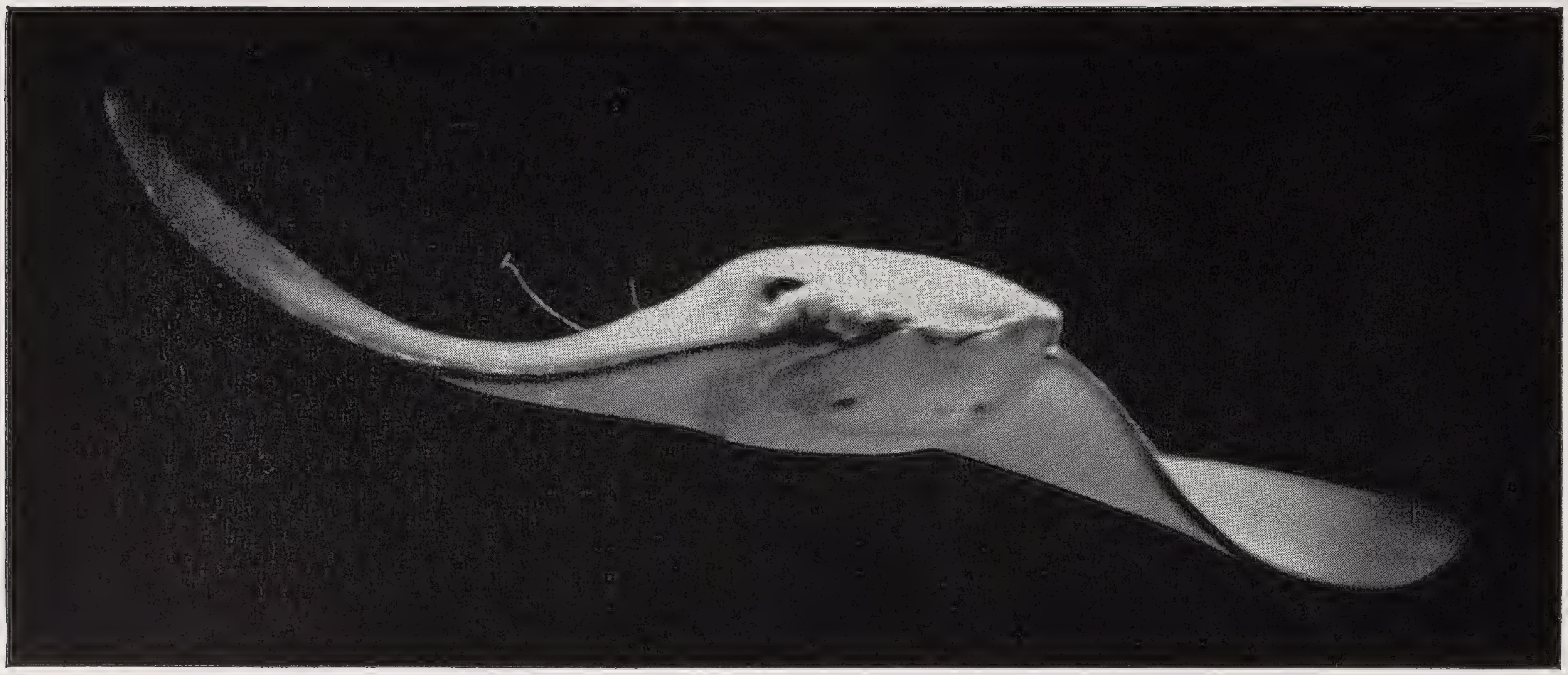
This appearance may be due to a lessening of acceleration, when the shift from upstroke to downstroke is being made. Also the wings themselves add greatly to the volume of water that must be displaced by the body as a whole, and on the recovery stroke they must be contracted or curved in such a way as to offer less resistance to the surrounding medium.

How is this effected?

Probably by the muscles, which can spread or contract the borders and surfaces of the wings in such a way as to present receding concavities to suck the water backward, gentle convexities to facilitate its flowing off to the side, and a rolling forward over the waves generated by the wings.

Why is the body tilted upward in forward movements?

I suppose that the center of gravity of the fish lies in the fore part of the abdominal cavity, slightly behind the gill openings. This alone would tend to raise the head a little. But the head would be raised also by a slight depression of the plane of the ventral fins, which although



The utmost in grace of locomotion is expressed by the cow-nosed ray as it "flies" lazily through the water on wings that are marvellously adapted to carry its body along with a minimum of effort and resistence.

small are far behind the center of gravity and in a good position to influence this movement.

Why does the tail trail out so far behind?

Perhaps it may help to steady the movements of the fish, especially in swirling waters. But it is also a lash and it carries a long sharp spike that often pierces the jaws of sharks that feed on eagle- and sting-rays.

Why is the wing so narrow at the tip?

There must be several reasons for this. In the first place, the wing-tip, being furthest from the center of gravity, has the most powerful leverage against it and therefore must be small in area to prevent too sudden and violent movements. Then again, the widest part of the wing is subjected to the most severe stresses and it is strengthened by the shorter parts on either side of it.

Why does each wing have such a long base along the side of the body?

The longer the wing-base, the greater the muscle-carrying area, hence the greater the power to throw the wing into undulations that start from the center and thrust obliquely backward. Also, the longer the wing-base, the greater up-and-down stability.

Why is the disk as a whole diamond-shaped?

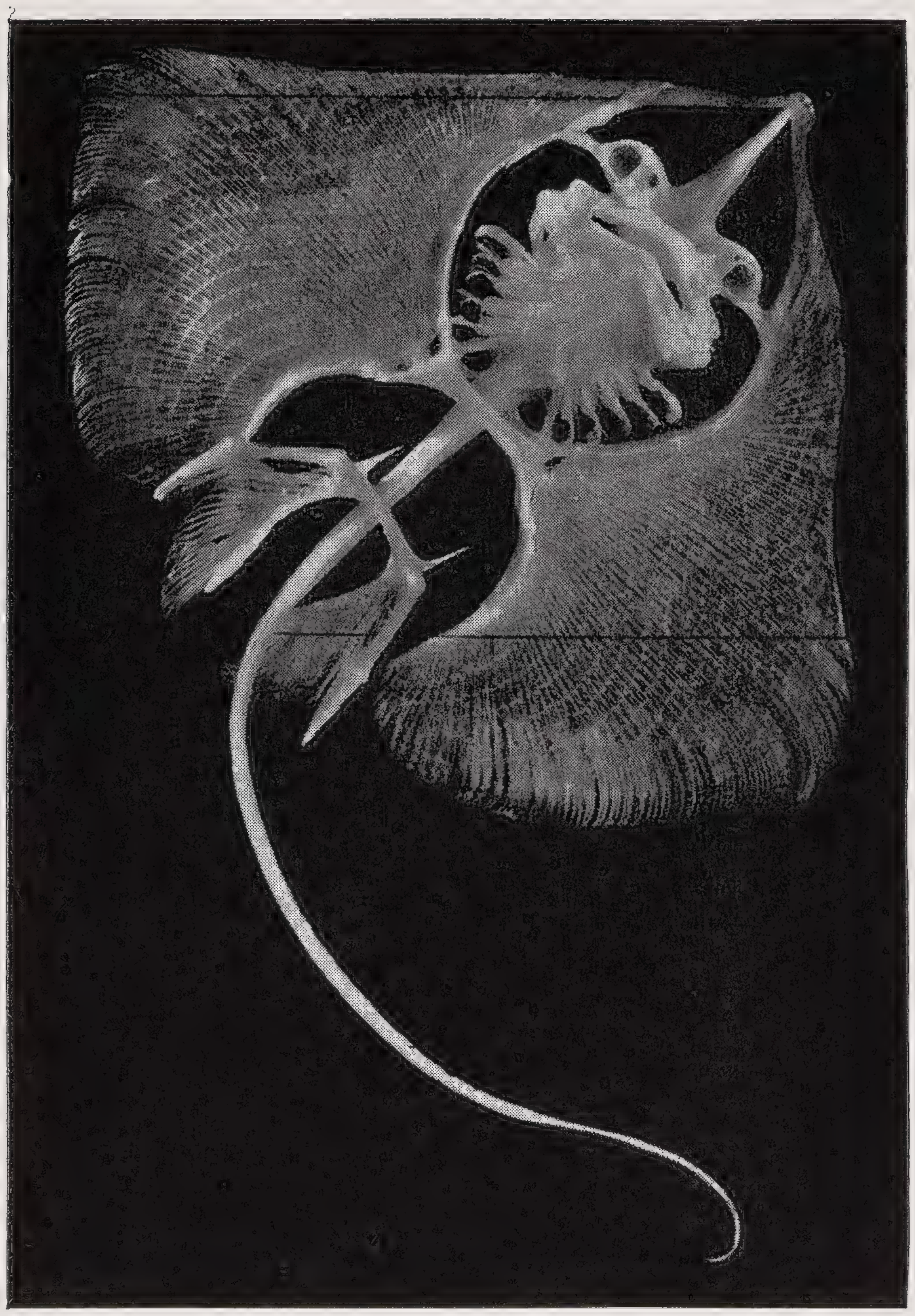
This is tied up with the previous question. Mr. J. E. Harris, who has been doing wind-tunnel experiments on models of fish body-forms, tells me that a triangular apex favors right-and-left stability for the simple reason that if such a body swings to the left, the right hand slope of the triangle comes out more into the current, while the left-hand slope is virtually shortened and meets less resistance. The reaction tends to swing the body back on its original course. In technical terms, a triangular bow increases yawing stability, due to "sweep-back."

But what makes the rear half of the disk more or less triangular also?

Well, the triangular effect of the rear half depends partly on the fact that in the growing embryo ray, where there is very rapid transverse growth at one point there are less rapid transversely growing parts on either side of it, all of which produce a triangle of some sort, depending upon the direction of growth of its tip. Now in the skates and rays the most rapidly growing parts in the transverse direction have been located somewhere near the center of gravity of the body, hence the wing-tips remain well in front of the horizon of the pelvic fins and consequently the rear border of the wings faces backward and outward, thus completing the diamond at the rear.

But what if the wing-tips turned and grew far to the rear?

Then the tips would become passive trailers, which would dampen the stroke of the wing as a whole. For some unknown reason this has not happened in skates and rays, although it has



(Photo A. M. N. H.)

This skeleton of a skate (Raja clavata) gives an idea of the internal structure necessary to its flexibility of motion.

happened in the dorsal and anal fins of angelfishes and others.

But why do certain skates have rounded disks?

Apparently in the round-disked forms the rounded outer border vibrates more freely and, like a flag waving in the breeze, there is less use of the wing as a whole in a single rhythmic stroke.

Why are the wings of the eagle-ray concave on their rear edge, while the rear borders of the wings of the butterfly-ray are convex?

A concave rear border permits the easy escape of the backwardly flowing water but a convex border gives a stronger thrust to this part in raising or lowering one or both sides. In the cow-nosed eagle-ray the ventral fins and tail are fairly well developed and are doubtless more important in steering than they are in the butterfly-ray, in which they are almost vestigial, and which must therefore depend chiefly upon the hind border of the wings both in changing elevation and in banking.

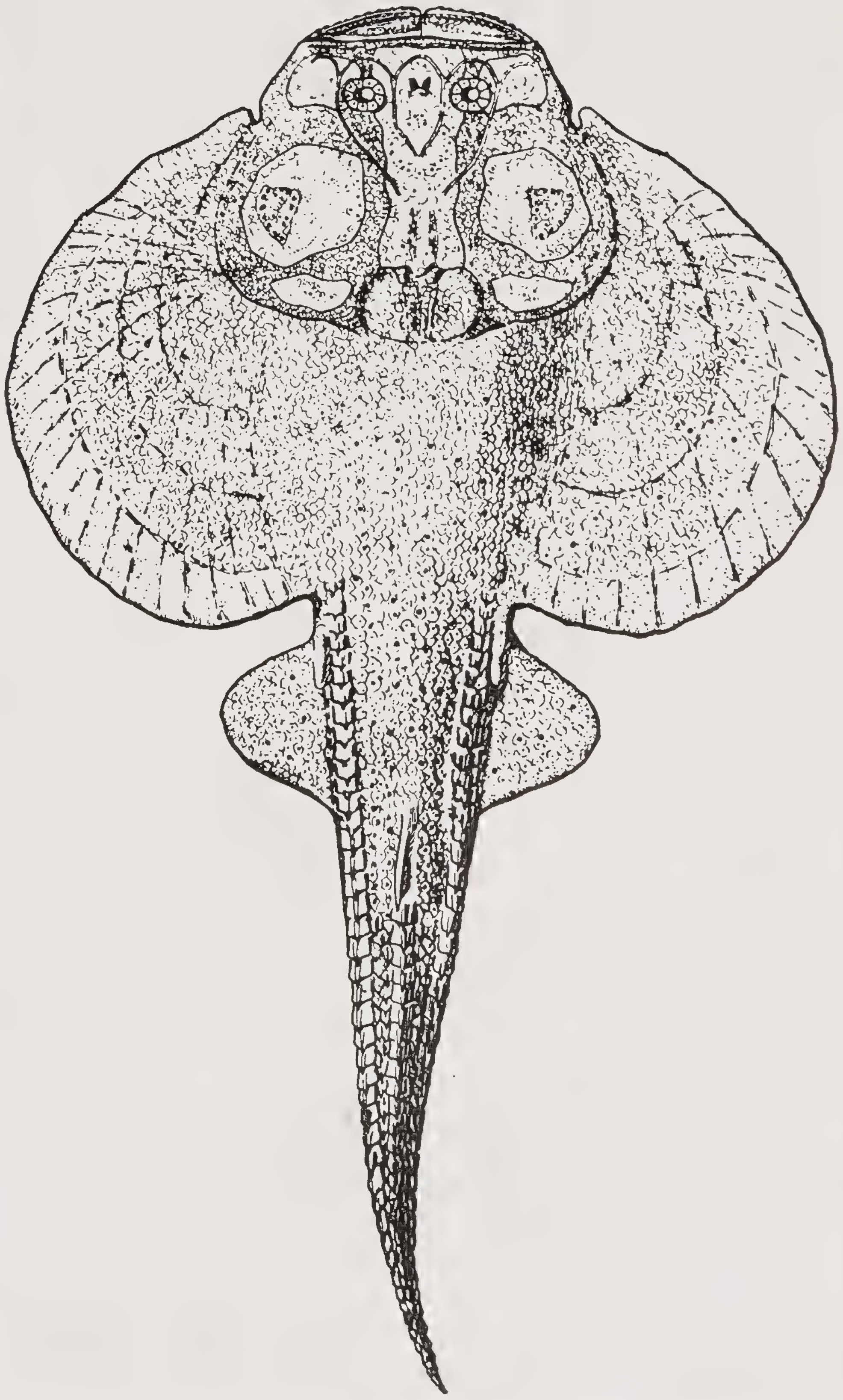
Are there any other advantages of a disk-like shape?

Rays are to some extent diggers as well as flyers and with a roundly triangular front border it is easy to shoulder one's way into the sand, while the short body-length makes it easier to push the sand to the rear.

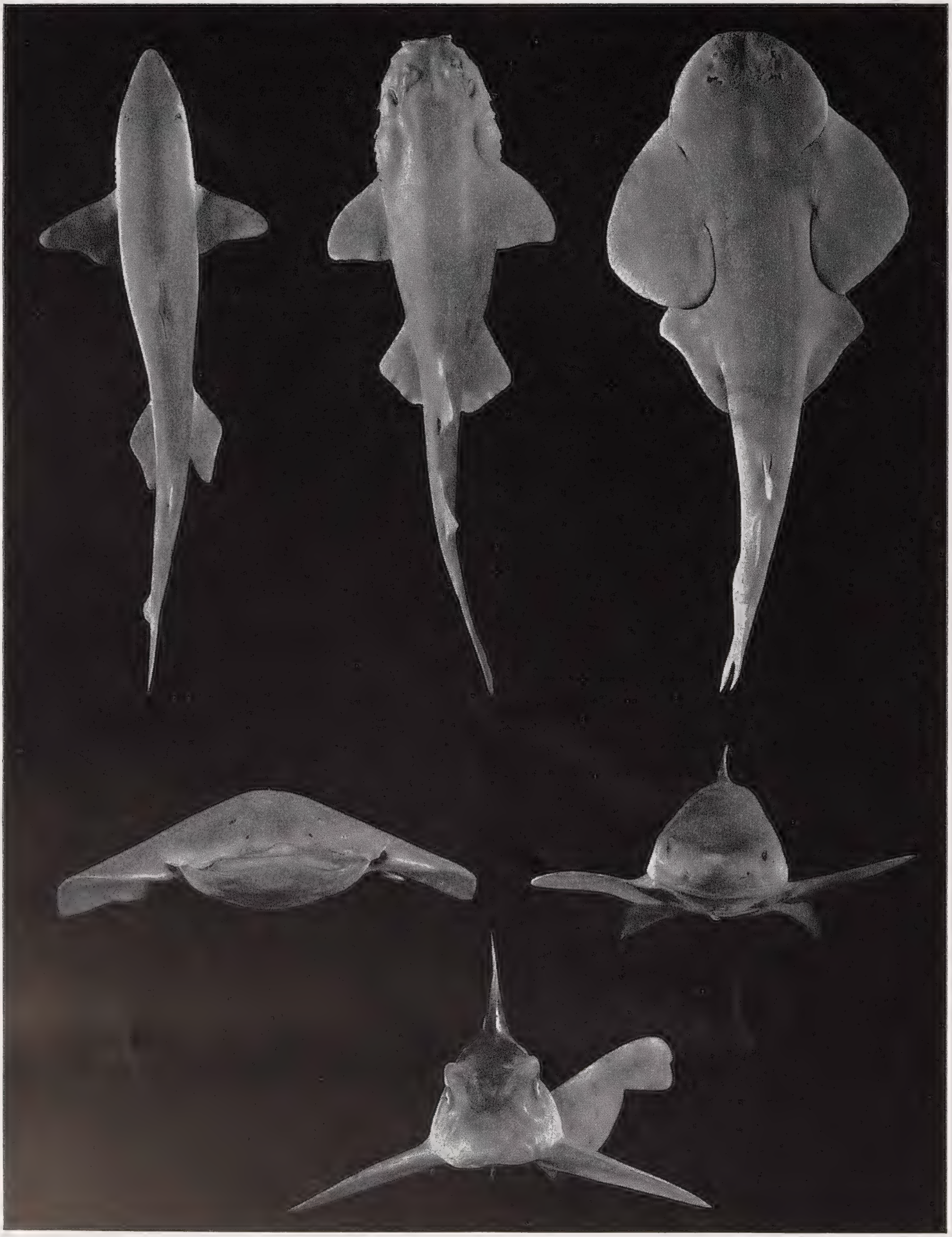
Finally, a slightly rounded diamond-shaped body offers an easy run-off for adverse currents and permits quick turning and tacking with minimum effort, an important consideration to an animal living close inshore and more or less buffetted by ground-swell and tide.

How are these wings supported?

Each of them is supported by a fan-like system of skeletal rods which start from near the middle of the body and branch outward, sub-



This fossil of Gemündina stürtzi from the Upper Devonian stands between sharks and rays. (After Broili.)



(Photo by American Museum of Natural History)

Stages in the enlargement and widening of the pectoral fins. (Upper, left to right) spiny-finned shark, carpet shark and monk-fish. (Lower, left, center and right) Monk-fish, Port Jackson shark and spiny-finned shark.

dividing as they near the outer border. Thus the flexibility is increased from the center outward. Each wing extends from the tip of the snout to a point above the pelvic or ventral fins and it is tied in to the side of the head and body by long cartilage rods. This very long wing-base makes up-and-down turning easy and gives a maximum spread of muscular power and leverage.

How are the wings fastened to the body?

The wings of opposite sides are tied to the shoulder-girdle, which is a stout bar running across the underside and ending above in fan-like expansions which are fastened to the backbone.

Where are the muscles that move these wings?

As in many of Nature's mechanisms, the motors are built into the walls of the moving parts, that is, they are spread out over the wings themselves. They are bunched toward the midline and fan out toward the border, warping the skeletal rods as they contract. The muscles of the wings are arranged in opposing sets, one on the upper, one on the lower, surface of the wings, so that these wings are practically self-flapping triangular flags.

Are there any fossil remains of the skates and rays of past ages that would show the steps by which the modern forms have gained their present high specialization?

The eagle- and sting-rays, torpedoes, skates, saw-fishes, guitar-rays, monk-fishes, etc., are known from numerous fossil teeth or teeth plates and sometimes from entire bodies, found in marine formations of various ages, but the interrelationships of the different families are not yet well understood. The earliest fossil rays, representing the monk-fishes, date from the Jurassic period, that is, the second period of the Mesozoic era or Age of Reptiles. Earlier ray-like teeth are doubtfully connected with the group. Recently an Upper Devonian form named *Gemündina stürtzi* has been described by Professor Broili of Munich, which in regard to general body-form is intermediate between sharks and rays, since it has wide-spreading pectoral fins, which however are not continued forward along the side of the head, while its pelvic fins and the hinder part of its body are shark-like.

But is this enough to justify the conclusion that skates and rays have been derived ultimately from sharks?

Not by itself, but there are several "living fossils" that have preserved the chief characteristics of the earlier stages in the transformation of sharks into rays. The spiny-finned sharks have retained a normal shark-like body but have already lost the anal fin, which is absent in skates and rays. There are various anatomical characters which tend to ally the spiny-finned sharks with the stem forms of the skates and rays. The carpet sharks, although belonging to a quite different group, illustrate an initial phase in adjustment to bottom-living in their broad heads and bodies, broad pectoral and pelvic fins and rearwardly placed dorsal fins. The monk-fishes carry further the widening and flattening of the body and the enlargement of the pectoral fins, which however are not yet tied to the side of the head. Moreover the gill slits are not yet displaced to the underside of the throat. In the guitar-fishes these important improvements have been effected but the pelvic fins are not yet overlapped by the pectorals. In the later stages, represented in the eagle-rays, the pectoral fins dominate to such an extent that finally in the butterfly-rays, with enormous pectoral fins, the pelvic fins are very small and the tail has almost disappeared.

In the butterfly-rays the diamond-shaped body attains its widest and most perfect form, while in the torpedoes and river trygons there has been a rounding of the disk almost into a circle, which seems to be advantageous for a more sedentary life. In the saw-fishes, on the other hand, the rostrum has been greatly elongated and the diamond has become much longer than broad.

Cumulative evidence in many similar cases indicates that when in the members of any diversified natural group some central structural pattern is found to be modified in various ways in accordance with different environmental conditions or habits, it may safely be assumed that the central pattern once existed in the common ancestors of the diversified descendants. Thus, although the first stages in the transformation of spiny-finned sharks into the direct ancestors of the skates and rays occurred at a relatively early geological epoch (?Upper Devonian), there are not wanting many traces, in the varied bodies of still surviving forms, to prove that just as birds are "winged reptiles," so rays are "winged sharks."

The lateral line is clearly indicated in this Pompeian mosaic, although nothing was known of its function then. (From "Die Antike Tierwelt," in Radcliffe's "Fishing from the Earliest Times.")

Studies on the Lateral Line of Fishes

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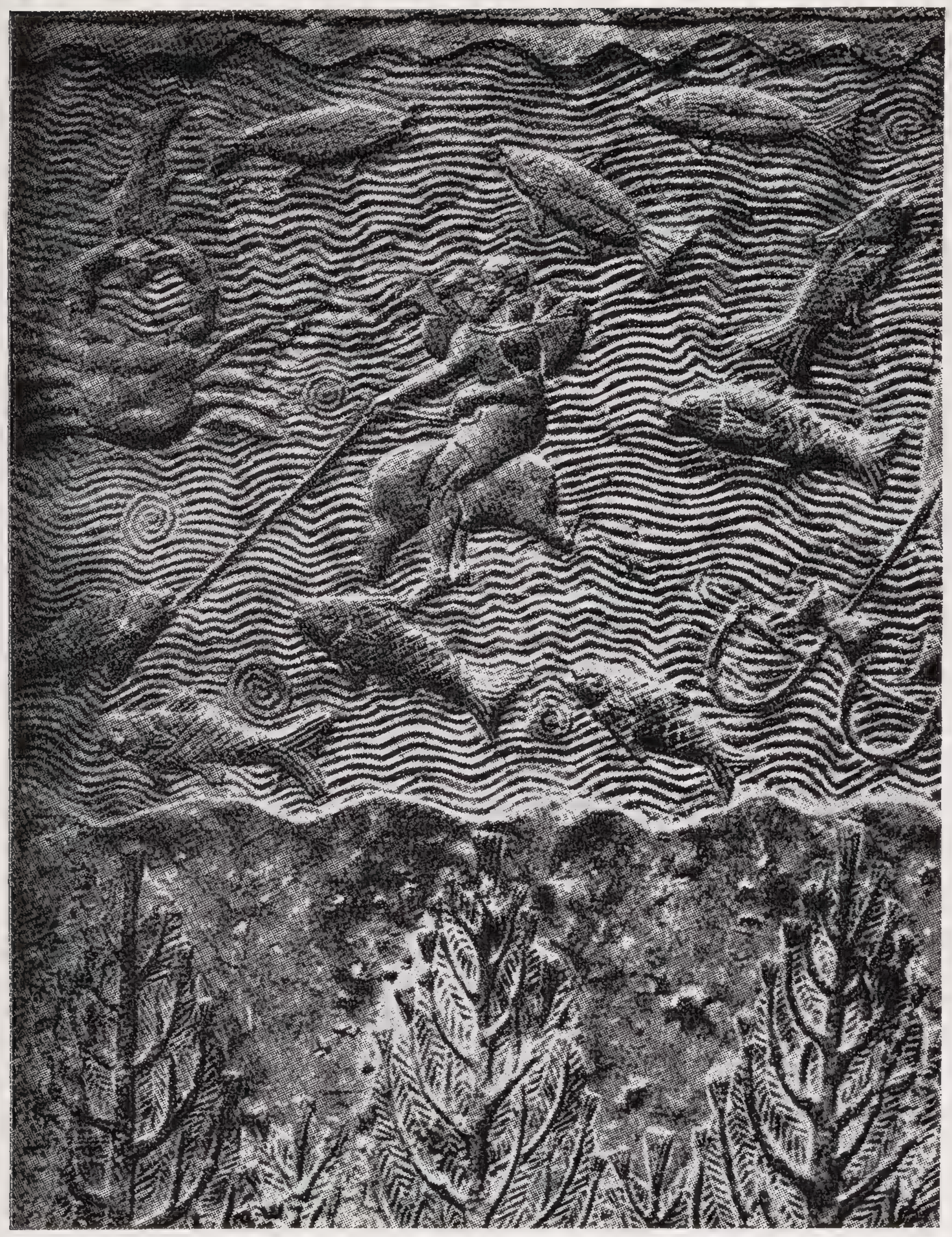
ALONG the sides of the body of most fishes, extending down to the tail, is a fine line called the "lateral line."

This peculiar linear mark of fishes has been known for many centuries. Its presence is indicated in some of the early drawings and sculptures of the ancients. In the middle ages, for instance, the lateral line is prominently displayed in drawings of fishes entering into heraldic designs. In the more modern anatomic engravings of fishes, beginning with the works of the Sixteenth Century ichthyologists, the lateral lines of the body of the fishes are clearly recorded. As an example may be mentioned the figure of a parrotfish reproduced in one of the earlier ichthyologies published in 1554 by Rondelet. The body lateral line is accurately drawn, but the continuation of the line into the head region, where it is now known to form important branches, was not traced, probably because these terminations were not recognized at that period in history. Nowadays the patterns of distribution of the lateral lines in fishes are an aid in identification and classification, and they vary in design over a wide range.

It was probably not until the Seventeenth Century that it was understood that the linear markings actually represented a system of small continuous tubes or canals lying under the skin or buried in the bones of the head, usually communicating with outside surrounding water by little openings through the skin or scales. It is known that at least three Seventeenth Century anatomists—Lorenzini (1678), Rivinus (1687), and Stenonis (1664)—were familiar with the canal-like structure of the lateral lines.

This conspicuous line, therefore, can be traced in many varieties of fishes from the tail to the head, with the naked eye. In the region of the head the lines are followed with greater difficulty on account of their deeper position. But with the aid of a microscope it is learned that usually the lateral line tubes of each side communicate and break up into three branches. Two of these almost completely encircle the eye on each side and terminate near the olfactory depression. The third branch runs back of the gill opening below the jaw to end near the lower lip.

The entire system of lateral line tubes is abundantly supplied with little buds or minute end-organs upon which sensations register, which in turn are carried by nerves to that part of the brain known as the medulla. The ultimate nerve ramifications are still a subject of study, but in general they seem to lie close to nerves which



Even Assyrian sculpture was careful to show the lateral line of fishes. (From "Fishing from the Earliest Times.")

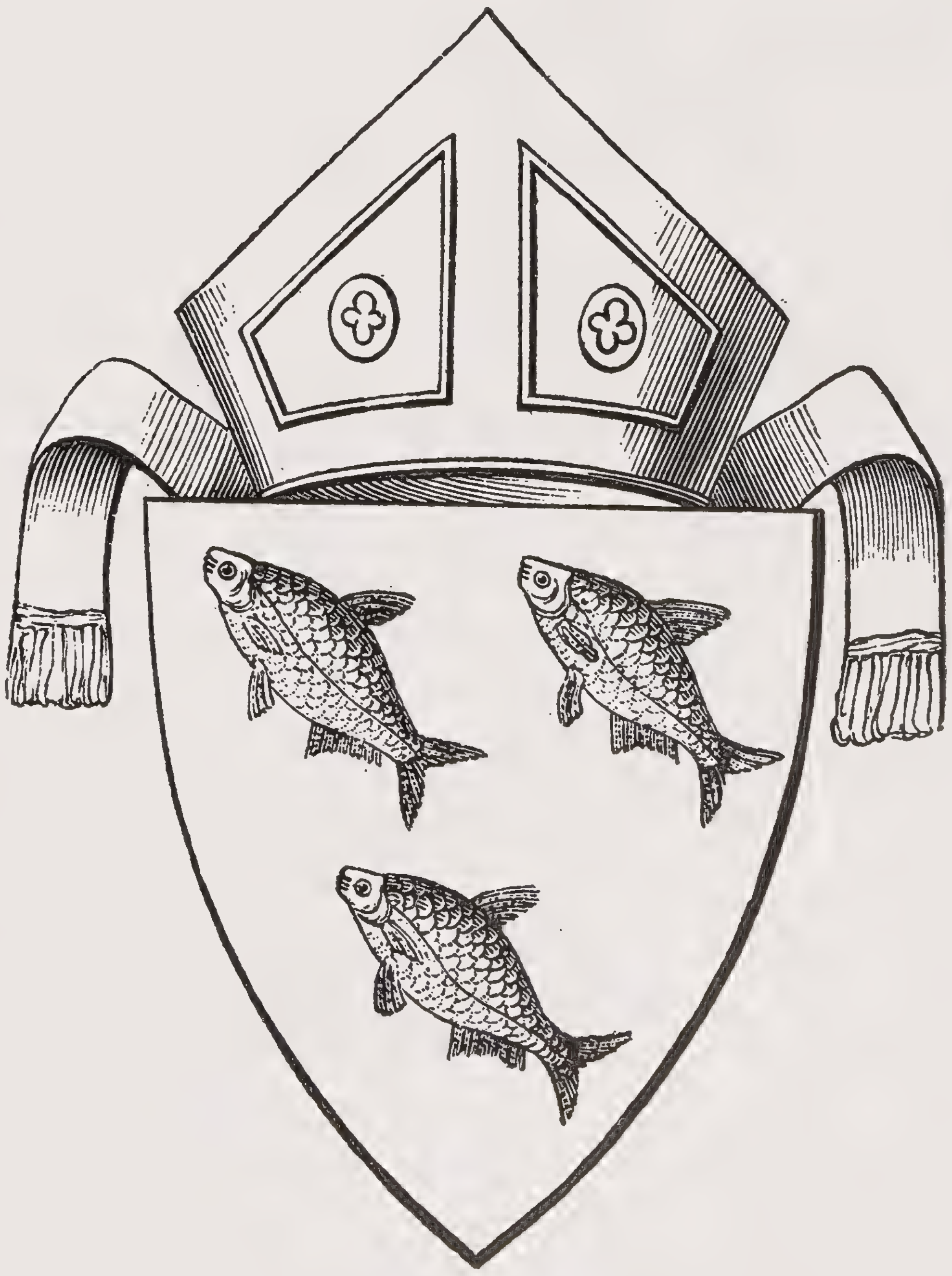
carry sensations of sound from the ear apparatus to the brain.

But just what sensations are transmitted by this elaborate apparatus from the lateral line canals to the brain are matters of great mystery even today, in spite of much study and experiment. Perhaps the question will never be settled. It is known that fishes already possess anatomically the necessary apparatus to register the usual "five senses" of terrestrial animals, *i. e.*, sight, hearing, smell, touch and taste. Leydig (1850) thought that fishes needed for their existence in an aquatic environment another sense, a "sixth sense," the sensory impulses of which were recorded by "lateral line" system. Support is given to this view by the fact that some amphibians possess lateral line organs during their early aquatic life which later atrophy and disappear when terrestrial habits are developed.

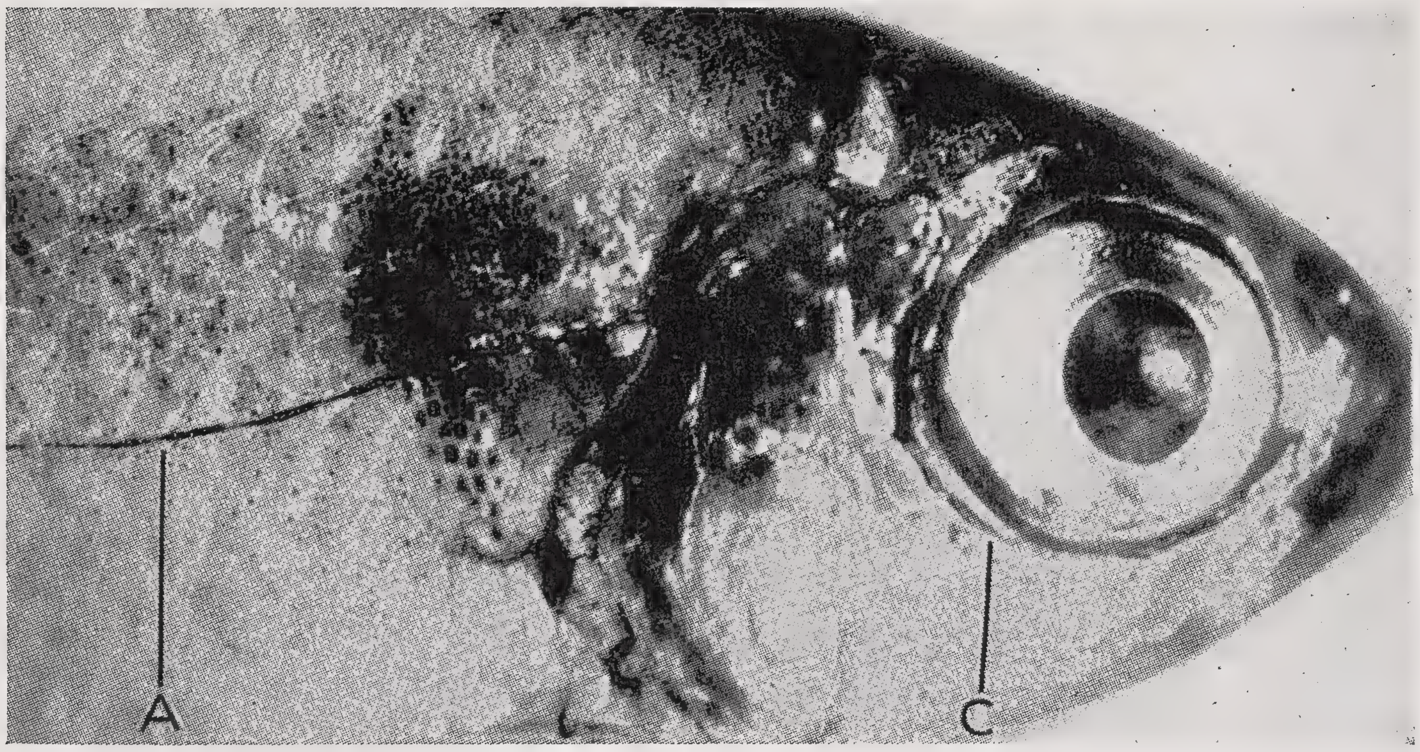
Earlier anatomists regarded the lateral line canals as furnishing mucus or slime designed to cover the body of the fish with a slippery protective material and to facilitate swimming. As a matter of fact, the canal system, besides possessing nerves, is actually lined with many mucus-producing cells. This slime can be pressed out through the skin pores of the canals in some fishes simply by exerting pressure along the surface of the fish. Slime or mucus is formed, however, by countless other mucus cells of the skin in fishes, and the "slime canal" theory as explaining the lateral line system was discarded.

More recent experimental studies have brought into prominence other views for the function of the lateral line system. Schulze (1870) thought that the apparatus recorded mass movements of the water or movements of the body through the water. Fuchs (1895) concluded that hydrostatic pressure was recorded by the lateral line apparatus. Lee (1898) thought that the lateral lines were of use in matters of equilibrium. Hofer (1908) gathered from his experiments that weak currents of water were registered by this part of the nervous system. Parker (1918) found that the lateral lines responded to vibrations which are slower than those which affected the auditory apparatus.

The experimental work on the function of



The lateral line was part of this heraldic design. (From "Heraldry of Fish," by Thomas Moule, London, 1842.)

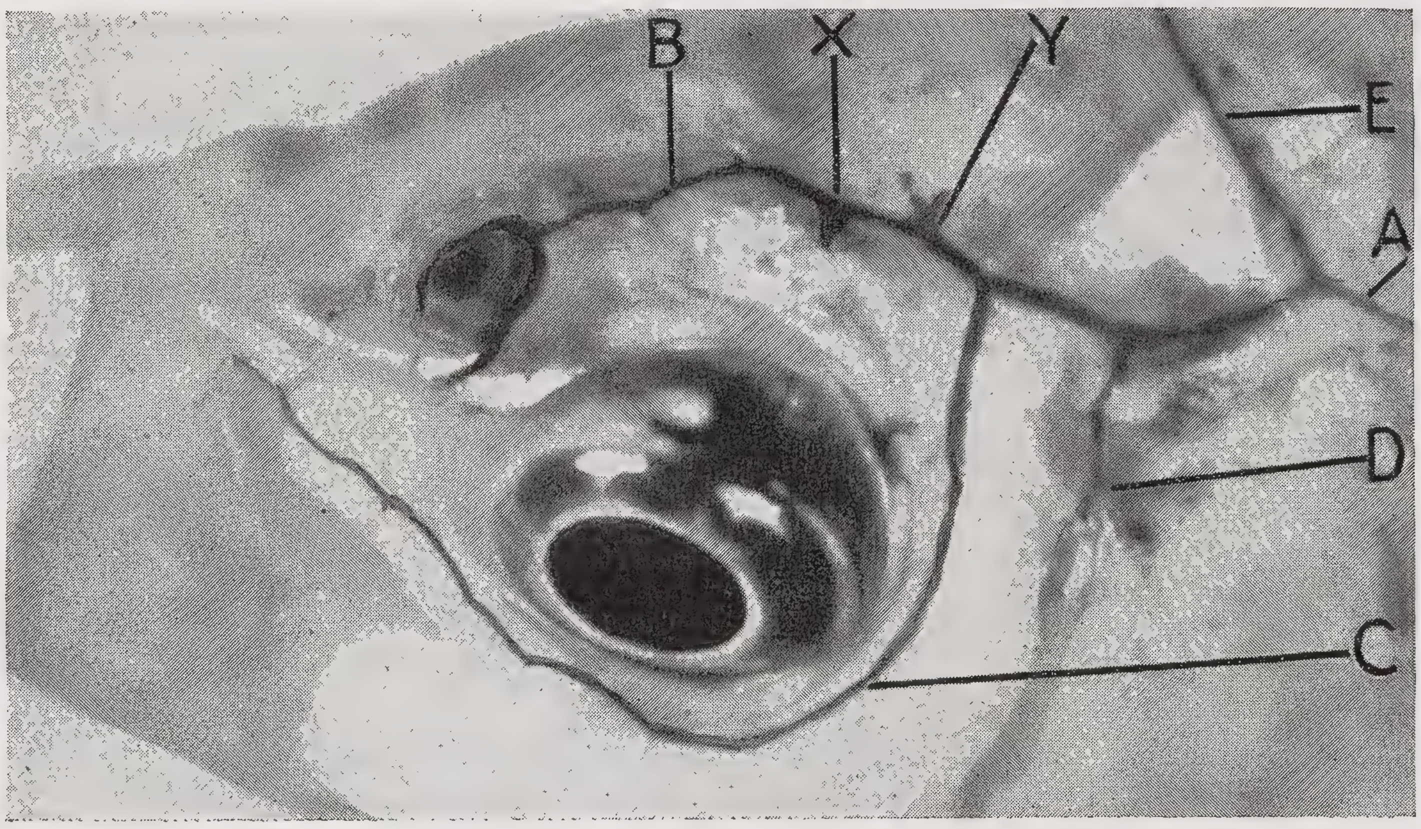


Living Hemigrammus, showing the lateral line of the body (A) and of the head (C) colored by India ink.

lateral line canals carried out at the New York Aquarium examined a theory that the lateral line canals might be a testing apparatus for chemical or physical properties of aquatic environment. Earlier experiments (Smith, 1930) showed that the lateral line canals of goldfishes, placed in water containing finely suspended particles of colored material, would quickly fill up with these easily detected colored substances. Fishes placed under the microscope in small dishes of clear water, after exposure to colored water, would in a sense "flush" out the colored fluid from the canals, by secreting mucus on the inside of the canals. Strings and plugs of colored mucus flowed out of canal openings and were washed away from the body of the fish by the surrounding clear water. Fishes kept in tanks of colored water for several months and examined from day to day might show days when the canals contained only clear transparent mucus, but on other days the canals would be filled with the colored solution, indicating again some sort of irregular intake and outflow of colored fluids.

A large number of fishes taken from various tanks of the New York Aquarium were tested by placing a few drops of a colored solution over the terminals of the lateral line canals near the tip of the nose, from which points the entire canal system of head and body can be filled. An idea was gained of the rapid intake of fluids into the lateral line canals of the head and body (2-3 minutes) and also of the time necessary for the outflow of these same colored fluids from canals into surrounding clear water (20 minutes to 1 to 2 hours).

Experiments of this character suggest that the lateral line system may partly, at least, act as a mechanism for the testing of chemical or physical properties of surrounding water; the canals of the lateral lines permitting an inflow, a period of testing, and later an expulsion of water. One might be lead to conjecture that such a method of water testing would be useful in determining the nature of physical and chemical evironment favorable for life or for purposes of breeding and thus, in the latter case, aid the sense of direction in fishes during their migration sometimes for thousands of miles.



Lateral lines of the head region of a goldfish colored by India ink. (A) Branch alongside the body; (B, C) Supra- and infra-orbital branches, respectively; (D) Branch to lower jaw; (E) Branch communicating with lateral lines on the opposite side; (X, Y) Openings through the skin.

The Genesis of a Front Page Story

C. W. Coates
Department of Tropical Fish

ONE hot day in the early summer of 1933 the readers of New York papers found on the front page and elsewhere a story about a "mystery bacteriophage" that had been discovered at the Aquarium and which was performing all sorts of cures in cases of skin diseases. Sufferers from hitherto incurable maladies were reported to have undergone immersion in water from the Aquarium tanks and to have emerged clean and whole again.

That is not an exact re-statement of any of the newspaper stories, but it is the tenor of them all and apparently the general understanding of the matter as read by the average layman, for on subsequent days sufferers from the most miscellaneous assortment of diseases flocked to the Aquarium, literally by hundreds, seeking a cure.

The interest with which the Aquarium staff read the newspaper articles was subordinate to its surprise and dismay for it knew what the reporters who wrote the stories overlooked—that the bacteriophage that was the basis of the reports could by no legitimate stretching of the imagination be considered a panacea for all skin diseases even though it was the cause of certain manifestations apparently of a healing nature. They also knew that the phenomenon must undergo long and searching investigation before it could be formally announced or claims made for it.

However, the story was "out," first in the New York papers and then in newspapers and magazines all over the world, and in spite of the denials that the Aquarium was in possession of a new "Well of Bethesda," we were besieged by sufferers from all over the continent.

Eventually the clamor died down, as such things do, and little more was heard of the 'phage in the public press, but since that time the phenomenon of the germ-killing waters discovered in the Aquarium has been under quiet investigation and while this is still going on and showing some progress, it is not yet time to make any reports—not until the matter is more thoroughly understood.

However, it will not, now, do any harm to tell how the "bacteriophage" story came into being, or rather, what its background was, although we must sincerely disclaim any miraculous cure-all and trust that the afflicted will not have any false hopes raised in their hearts.

If the 'phage is found to be of definite value in any morbid condition, it will be made available through the proper medical channels and not through the immediate agency of the Aquarium.

In the world of fishes there are a number of smaller creatures which are so constituted, possibly by natural selection in the feral state, that they can live fully and comfortably in comparatively very small bodies of water which superficially remain unchanged for long periods. Representatives of this group are kept in small aquaria as domestic pets over a great part of the world and are usually encountered under the name of "Tropical Fish," since most of such species have their origin in the fresh waters of the warmer countries of the earth.

However, water in which any living material has its being does not for long remain simple water. In fact, in pure, distilled, H_2O, fishes will not live at all, but it is possible to take comparatively pure water, such as is supplied by civilized communities, and set up and keep more or less indefinitely a number of smaller fishes. Their existence is not as simple as it appears on the surface, for there is created a biological cycle without which the fishes will not live. Being living animals, they have the power to change chemical compounds of many sorts to suit themselves, and to throw off the parts not required. This entails a constant production of waste products. In addition, there is a constant supply of food-stuffs and air-borne particles of matter, both living and dead, in the water which must be absorbed and their effects aborted if the water is to remain sweet enough to support the fishes alive. Most of the dead matter is more or less inert and merely sinks to the bottom, the soluble material being dissolved and becoming part of the water complex in the tank. With the living matter there is not the same easy solution. Much of this is bacteria which is to be found floating about in air, and proteid matter supplied to the tanks as food for the fishes. This, added to the waste products of the fishes, would soon become a biological "stew," quite unfit for fish habitation, unless there was a process of material to prevent the combination from becoming harmful.

Assistant Director Breder, being dissatisfied with the lack of information on certain of the procedures by which the water was kept in good condition, found a tank in 1930 which was ideal for investigation. It had been established many years before and had contained as inhabitants a succession of fishes of different types. The peculiar thing about the tank was that although large portions of proteid matter—fish food—might be thrown into the tank and allowed to decay and a terrific population of bacteria formed, in this case *B. coli,* within a few hours the water would be perfectly sweet and clear again. In 1931 Mr. Breder reported the presence of a lytic agent—a bacteriophage—in the water, which was the active substance in the prevention of spoiling. No further reports were made.

A number of tanks, however, were still kept under observation in the Tropical Fish department. Some of the results, for which we have no explanation, were that if certain kinds of fishes were kept in unchanged water, it would become toxic to other kinds of fishes. Other observations were that in certain of these waters cuts and small infections would heal over and disappear with rapidity. Without definite knowledge of the agent responsible for this, in fact without any definite knowledge of what a "bacteriophage" actually is, discussions with other biological and medical investigators resulted in the bathing of some chronic infections of the skin with types of the water. A number of such bathings of more or less unidentified infections, usually listed under the generic title of "eczema," resulted in considerable relief of the affected parts, although no adequate explanation was forthcoming. Such, however, is frequently the history of obscure biological phenomena.

Unfortunately, one of the experimental subjects was so relieved of his disease that he talked with all and sundry, the tenor of his remarks finally being picked up by a newspaper reporter who, finding other "evidence," published a story about the mysterious "bacteriophage." This was seized upon by other newspapers and then the matter got out of hand.

A "cure-all" of the kind reported is, of course, preposterous, and the hopes that were raised in the minds of sufferers from various ills and the annoyance caused the Aquarium staff were considerable. However, since the nature of the activity of the water was not understood, many samples were sent to various hospitals, laboratories and scientific investigators. Their reports varied in the extreme. Some investigators reported the presence of a weak bacteriophage, some reported active lysisyme, and some stated that there was nothing at all in the water.

Competent medical authorities in New York, however, agreed to make critical examinations of infections treated with the material, and their reports were to the effect that while relief was experienced by some sufferers, none was experienced by others, and a possible explanation of the apparent relief as reported was that it was psychological rather than physical. This series of investigations was abandoned, but a series started in England with precautions against any psychological influences, shows some definite progress. Naturally there is a considerable aversion to making any reports until the subject is better understood.

However, Dr. Frances I. Seymour of New York has prepared a report, to be published shortly,[1] of the surprisingly beneficial effects following treatment of several cases of vernal catarrh with the water. This report has been held up for two years so that an idea of the permanency of the results may be obtained. To date there has been no recurrence of this troublesome affection of the eyes in the cases treated.

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[1] Seymour, Frances I. *Journal of the American Medical Association,* (In press).

Fish in the Faucets

Some Unusual Aspects of Water Supply Control

Herman Forster
Deputy Commissioner, Department of Water Supply
New York City

THE problem of bringing adequate, pure, pleasant looking and tasting water to a city of seven million people is extremely complex. Naturally, the engineering, chemical and bacteriological aspects of water supply work have drawn to our Department experts in those several fields, and in consequence our city enjoys water second to none in the world.

Our water is derived, in the main, from three great watersheds aggregating more than nine hundred square miles in area. The two northernmost ones are the Schoharie watershed in Greene county and the Esopus watershed in Ulster county. These sizable areas are augmented by the Croton watershed in Putnam and Westchester counties.

The supply from the Schoharie and Esopus watersheds is carried to the city by means of the Catskill aqueduct, via Kensico and Hillview reservoirs, and the Croton supply is piped to the city by means of the Old and New Croton aqueducts, by way of the Jerome Park reservoir in the Bronx.

At the time the necessary lands were condemned for the creation of these three largest watersheds, the city acquired marginal strips around all our lakes, streams and reservoirs to insure the continued and permanent purity of the supply.

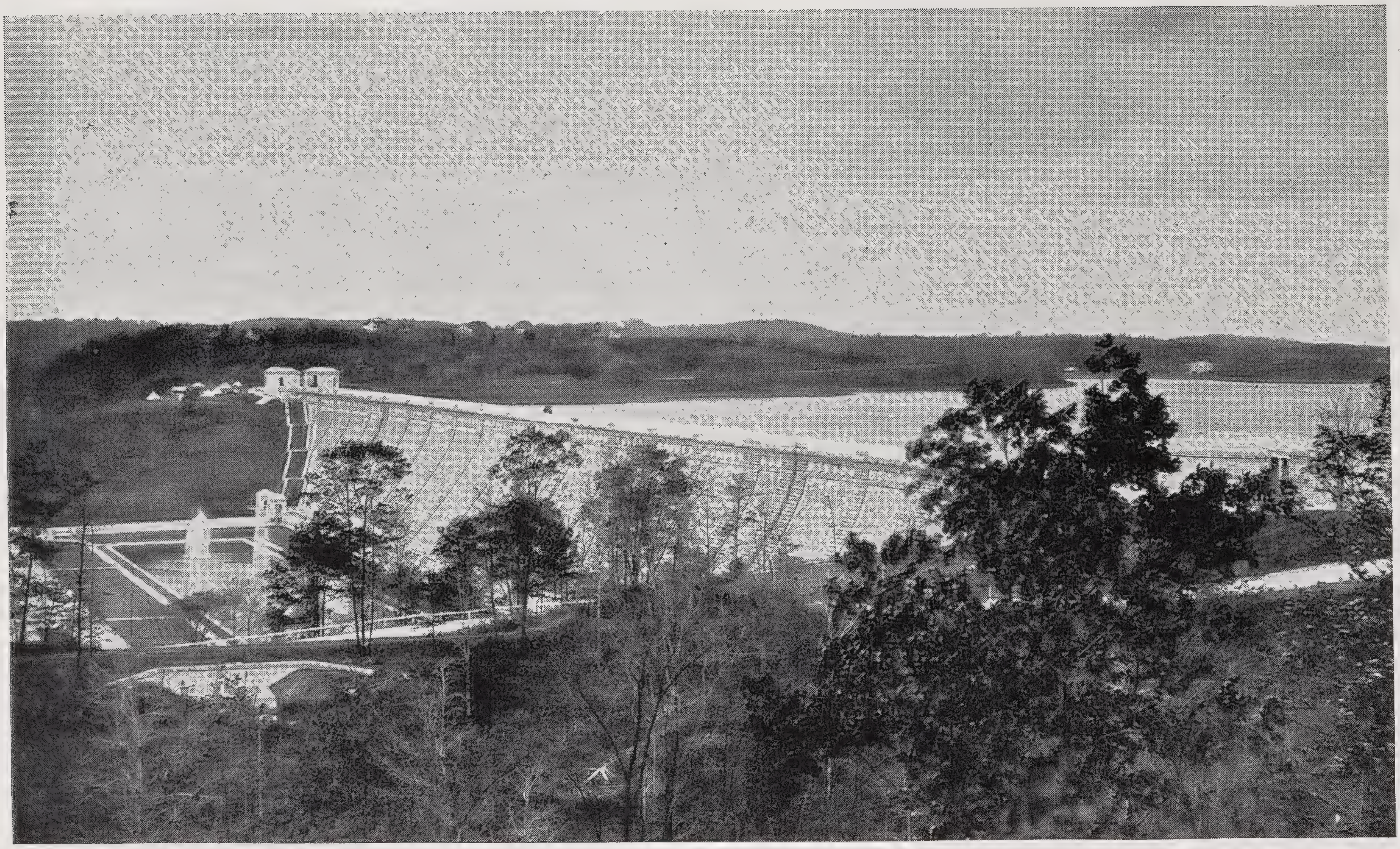
In Chapter 724 of the Laws of 1905, Section 38, it is provided that "nothing herein contained shall authorize or empower the City of New York to prohibit the public from using the said lakes or reservoirs * * * * for the purpose of * * * * fishing;" and in Chapter 725, Section 7—"any natural lake or reservoir * * * * may be used by the public for the purpose of * * * * fishing * * * *, and to provide for such use and uses, said City and its representatives are herein required to afford access to said lakes and reservoirs."

On the one hand, therefore, the City of New York protected its water supply by acquiring marginal lands to diminish any possibility of pollution, and on the other hand the enabling statute gave our citizenry the right to fish. This problem has heretofore been overshadowed by the tremendous engineering, chemical and bacteriological phases of our work and has not received the attention I think it deserves.

Last fall, from September to December, I received a number of complaints daily that fish were popping through Bronx faucets, to the consternation and embarrassment of housewives who received more than they expected. Upon analysis, it was found that all the fish so unceremoniously foisted upon our citizenry belonged to one species, and were identified as *Pomolobus pseudoharengus* (Wilson).

It seems that some enthusiastic disciple of Izaac Walton, many years ago, wanted to give the predators of Rye and Kensico a forage fish upon which they could fatten, and introduced this species, also known as the alewife, sawbelly or false herring. Apparently it responded to the charms of Rye and Kensico lakes beyond all expectation and multiplied to such a degree that it has become a definite Water Department problem. In vain we assured housewives that the sawbelly does not affect the purity of the supply, and inasmuch as their multiplication from year to year multiplied the number of complaints we received, it behooved us to undertake some method of control.

Upon consultation with our engineers, we found that our entire supply was screened through a mesh five-eighths of an inch square, and that this afforded easy egress to the slim, immature sawbelly. I was informed that we used



From the Kensico reservoir, held in check by this magnificent dam at Valhalla, New York, came the tiny little "false herrings" that so annoyed water consumers that the Aquarium was called into consultation on a solution of the problem.

approximately one billion gallons of water a day, and that six-tenths of that amount was taken daily from Rye and Kensico. I suggested reducing the size of the mesh so that the output of our faucets would be confined to water.

Our engineers, with a disarming frankness, pointed out that that was entirely feasible but that by reducing the size of the mesh I would, likewise, reduce the volume obtainable from Rye and Kensico. As that volume comprised more than half of our entire daily supply, I was stymied, and had to cast about for other corrective measures.

Through consultation with the United States Bureau of Fisheries, I learned of the use of electrically charged screens in some of the western salmon rivers which, it was thought, might keep these tiny trespassers from our outlets and thus solve the problem. But when I proposed this to our electrical engineers, I found that this, too, was impracticable, because we drew from varying depths, and a comprehensive installation would cost substantially more than our already depleted budgets could carry.

Finally, it dawned upon me that this was neither an engineering nor an electrical problem, but an ichthyological one, and I hied myself to the New York Aquarium where, under the patient and tolerant ministrations of Director Townsend and Assistant Director Breder, the problem was given consideration from the standpoint of the ichthyologist and the fish culturist.

Kensico lake has a maximum capacity of thirty billion gallons, and a maximum depth of 150 feet. I was informed that sawbellies had been found at a depth of 165 feet.

I learned that the reason these fish had apparently gone out of bounds lay in the fact that their natural enemies were limited to those comparatively shallow water fish found in most of our eastern lakes, and that before any effective campaign of control could be instituted against our trespassing fish, predators who waged war at depths greater than forty or fifty feet would have to be introduced.

I confess to being an ardent, though not often successful, fisherman. For the past fifteen years

I have made sporadic excursions upon the watersheds which are now the subject of my administrative control. I found that Kensico and Rye (virtually one lake) contained both basses (large and small mouthed), some pickerel, some white and yellow perch and some sunfish, all comparatively shallow water species.

Dr. Townsend and Mr. Breder therefore suggested the advisability of stocking Kensico and Rye heavily with rainbow and lake trout, the rainbows to wage war upon the sawbellies where the basses left off, and the lake trout to carry on in the great depths.

Thereupon we consulted with officials of the New York State Conservation Department, notably State Fish Culturist Sumner Cowden, and Doctors Embody and Moore of the State Biological Survey.

Through a coordination of the activities of the United States Bureau of Fisheries, the New York Aquarium and the New York State Conservation Department, our Department of Water Supply received some 71,000 alevin and fingerling trout, a substantial number of which are now being reared to maturity at Jerome pumping station in the Bronx. In this way we hope to combat a nuisance and, at the same time, make for a "shorter time between bites" for fishermen.

As an additional source of large, wild grown fish, and to lessen contamination on our Bronx-Byram watershed, the Department, with TERA funds, hopes to close off Wampus reservoir, rebuild its dam and raise water levels by five feet.

In order to do this it becomes necessary to drain this small natural pond. In cooperation with the Conservation Department and employees of the New York Aquarium, we have secured many valuable fish for exhibition use at the Aquarium and for restocking purposes in other lakes.

It is proposed when our project has been completed, to introduce into this pond some 5,000 to 10,000 rainbow trout annually, and when they have shown the growth our fish culturists expect, to drain the pond and transfer the fish to other bodies of water.

The danger of contamination will be lessened by prohibiting trespassers of any kind, including fishermen, from having access to the pond.

There are other important aspects to this problem. As I have said, fishermen are with us by law. From the reports of our watershed inspectors, it appears that some 50,000 persons annually avail themselves of the privilege of fishing on our lakes, streams and reservoirs. This is not surprising when, from an examination of the map of the areas adjacent to New York City, it is apparent that the only sizable, non-posted bodies of water to which fishermen may turn comprise our watershed lakes and reservoirs.

They are readily accessible and may be reached with the expenditure of but a few cents for transportation. The number of anglers has increased continuously, particularly during the depression. The man who, a few years ago, could go to Nova Scotia, New Brunswick, Maine or Canada, now finds himself limited to a day's excursion near the city.

Until Kensico Lake is stocked with more predacious fish, sawbellies will still have to be scraped off the screens through which New York City's drinking water is passed.

With this abnormal increase in the number of fishermen, our fishing is rapidly deteriorating. The job of restocking is one for the Conservation Department, but it too has felt the depression and the consequent depletion of its budgets.

We are hoping, therefore, again through the coordination of the activities of the Bureau of Fisheries, the New York Aquarium and the New York State Conservation Department, to be able to increase our activities at Jerome pumping station not only to combat the sawbellies in Kensico but to increase the number of game fish in all our watershed lakes and streams.

Most of our streams are conduits, transferring water from one reservoir to another. When they were originally created, little if any attention was paid to the problem of the fish life in the streams.

In times of drought, or when our engineers deem it advisable to draw water from other reservoirs, some of these conduit streams are seriously depleted, resulting in a mortality of the trout now existing in them.

It is hoped, through the medium of a CCC camp, now a reality at Goldens Bridge, New York, to inaugurate a program of adequate stream control under the direction of Dr. Greeley of the New York State Conservation Department, so that water levels in these connecting streams may be kept up throughout all seasons of the year.

After all, the Water Department is a "service" organization and any service organization must continuously strive to build up a reservoir of good will among the people it serves.

It has been said that "water is such a commonplace material that, through a meter and faucet, it is poorly appreciated . . ." but when put to recreational uses, such as fishing, it is "more intimate, more alluring, more romantic."

We preach the conservation of water to the bored multitude. Who, better than the fisherman, appreciates the effects of a drought, when the water is drawn down and the adjoining fields and meadows are parched and burned for lack of rainfall? What better nucleus is there to develop intelligent supporters of the Water Department's conservation policies than the men and women who have for years used the facilities which our Department, in cooperation with Mother Nature, has provided for their use?

This announced gesture of cooperation on our part has met with splendid results. On many occasions fishermen and boating permittees have telephoned to our office calling attention to some violation of our regulations and suggesting that an inspector be assigned to watch for any recurrence.

Most of what I have outlined in these preceding paragraphs is already an established fact in some of our progressive western cities. I was very much impressed by the successful recreational use of the watersheds of San Diego, California.

I find that not only do some of our American cities subscribe to such recreational uses as fishing, but that Blagdon Reservoir which supplies the city of Bristol, and Gladhune for the city of Edinburgh, are used as public fishing resorts, and suitable fees are extracted from fishermen.

Commissioner Davidson and I have felt that while we might impose nominal charges for boating and other permits relating to the recreational use of city property, we would, in the imposition of such a tax, completely lose sight of the fact that we are a service organization and that it is far more important to receive, in return for limited privileges, the wholehearted good will of our consumers than to collect a sum of money inadequate to cover its collection and auditing expenses.

Much of what has been discussed here is still in the embryonic stage. We hope, within the next few years, to develop a group of men, women and children who will enjoy our facilities to the utmost, who will have a keen appreciation of the true functions of this Department and will ever be alert to prevent contamination of our supply, and sufficiently grateful for what we do for them to preach that doctrine, as well as the ever present necessity of conserving that which Nature so bountifully gives us.

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The Electric Eel

FOLLOWING a line of experiments started some years ago to determine, if possible, the nature and amount of electricity given off by the various electric fishes, we have recently found an electrical circuit sufficiently robust to withstand the discharges given off by a five-foot-ten-inch specimen of *Electrophorus electricus*, delicate enough to catch the discharge and sufficiently fast to translate it into something that we could at least see.

The voltage given off by the electric fishes has been variously estimated at values ranging from thirty-five to six hundred, and the rapidity of the discharge at about one ten-thousandth of a second, repeated at intervals of about one-tenth of a second. With such a spread in the voltage, and so indefinite an estimate, it was difficult to work out a circuit which would be at once delicate enough to catch small, rapid discharges, and robust enough to take any heavy discharge the fish might liberate, for we have no way of regulating his discharge, although the fish has. A number of sets of electrical meters of varying capacities were tried and ruined, but in these cases the fishes under experiment were creatures which had been captured when large and fully mature, and did not take to tank life very well. Their discharges were frequent and vigorous and destroyed our apparatus without divulging any secrets about the electricity.

However, the eel which is the subject of the present series of investigations came to us about three years ago, grew up in the institution, and became comparatively tame—so tame, in fact, that unless it is thoroughly annoyed, it can be handled with impunity and will answer when called. This fish seldom discharges heavy shocks and seems a suitable creature to investigate.

At first none of our circuits would work at all, but by various changes and eliminations we were eventually able to make a neon tube light when it was connected between the eel and the investigator's arm. This circuit lit the tube and did not seem to annoy the fish, but it was not very satisfactory as far as the investigator was concerned, so the circuit was changed. One side of the tube was grounded and the other connected by a short wire to the water in which the eel swam. Such a circuit is absurd from an electrical standpoint, for the water in the tank is grounded in a number of places. Just to make matters more absurd, a sort of antenna of aluminum wire was wound around a wooden crosspiece and inserted in the water at one end of the tank and a similar arrangement inserted at the other end, with a neon tube of two watts and indefinite voltage connected between these two spiderweb affairs. This was satisfactory at first, for the fish would discharge whenever it came in contact with one or another of the antennae and the tube would glow, but after the first day or so the eel became accustomed to these wires and ignored them.

By this time, however, the public had heard of the fish which lit the lamp and swarmed into the Aquarium to see for itself, so it was found necessary to mount two neon tubes in the exhibition hall, above the tank and to disturb the eel mildly so that it would discharge and light the tubes. It was also found necessary to do that at stated times—11:30 A. M., 2:00 P. M. and 4:00 P. M.—so that those of the public who wished to see would not have to wait too long. To date the only apparent effect upon the eel has been an increase in its appetite and an unwillingness to come to hand when it is called.

Investigations into the nature of the electricity are still proceeding. So far we have been able to demonstrate that the current may be released from any part of the body of the fish with equal intensity; that it is directional, having one polarity at the head and another at the tail; that it is of at least eighty volts value; that the fish can regulate the amount it discharges, and that it can be made to actuate any ordinary electrical circuit of the appropriate value—all facts which have been highly hypothetical hitherto.

C. W. C.

"Open Air" Aquarium

In the sub-tropical climate of Key West there has recently been established a free public aquarium on what may be described as an "open air" plan.

The structure is rectangular in form, 126 feet in length by 40 feet in width, with a courtyard containing three large open pools. There are 12 large glass-fronted exhibition tanks of the usual type along each side of the courtyard. The passageways for visitors along the two lines of tanks are sheltered by wide porticos. The tanks containing the living marine exhibits, being open to sun and sky, are therefore brilliantly lighted. The exhibits consist chiefly of showily colored fishes from local waters.

We know of no other public aquarium constructed on such a plan. It appears to be well adapted to the climatic conditions prevailing there. The open air character is reported to have been suggested by Dr. Van Duesen, director of the aquarium at Philadelphia.

C. H. T.

Two Marksmen

The arrival at the Aquarium last June of two small archer fishes, *Toxotes jaculator,* was a source of much satisfaction. We have had a number of shipments from friends stationed in various of the East Indian islands but in no case have the fish survived the trip to New York, although a few specimens have safely travelled as far as Chicago, and two as near to New York as Philadelphia.

The two specimens which arrived here alive were much the worse for wear, each having been injured in an eye, one in the right, and the other in the left. Although we thought the creatures could be nursed back to health, we had doubts about their ability as marksmen. However, after a rest of ten days in a "hospital" tank, they made a very good showing, missing the first shot but registering bull's eyes on each of the succeeding fifty or sixty tries.

Since the injured eye of each fish showed a considerable improvement, they were deemed sufficiently strong to withstand the rigors of exhibition and were consequently placed in one of the small tanks in the tropical fish section where they created considerable interest among our visitors, inasmuch as this is the first time living archer fish have been exhibited in New York.

Our specimens are not more than three inches long, even now, and we hope to keep them long enough for them to achieve their full size—eight or more inches.

In the event that some of our readers do not know of the archer fish, it might be mentioned that it has the ability to eject a drop of water from its mouth at an insect perched or flying above the surface of the water. When the drop hits the insect, it becomes wet and unable to fly, falls into the water, and the fish then catches it. Full size specimens are recorded as "shooting" for a distance of ten feet or so, and while we have no knowledge of the full range of ours, they have ejected a drop of water to a height of five feet at an angle of about ten degrees from the vertical.

C. W. C.

Reference Book

Some years ago the dean of American ichthyologists, Dr. David Starr Jordan, produced a work entitled, "A Classification of Fishes, including families and genera as far as known." This huge compilation of the scientific names that have been applied to fishes, which was published by the Stanford University Press, soon became exhausted because of the great demand for it among students of fishes. Copies have become increasingly difficult to secure. Consequently it is of considerable interest to such students that the Stanford University Press announces that this valuable work of reference has been reproduced by lithography and is again available. The price is $3.50 for a paper bound copy and $4.25 bound in cloth.

C. M. B.

PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-IX and XI-XVIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Some Books by Members of the Aquarium Staff:

Breder: Field Book of Marine Fishes of the Atlantic Coast. 332 pages, 403 illustrations, 8 colored plates. $3.50.

Coates: Tropical Fishes as Pets. 226 pages, 56 illustrations, 11 colored plates. $2.50.

Mellen: Fishes in the Home. 178 pages, 63 illustrations. $1.10.

Nichols-Breder: Marine Fishes. 192 pages, 263 illustrations. $1.40.

Townsend: The Distribution of Certain Whales. 50 pages, 4 charts in color, 2 illustrations. $1.

........: The Fur Seal of the Galàpagos Islands. 13 pages, 11 illustrations. 75c.

Townsend: The Cultivation of Fishes. 27 pages, 17 illustrations. 35c.

........: The Porpoise in Captivity. 11 pages, 14 illustrations. 30c.

........: Galàpagos Tortoises. 82 pages, 45 illustrations. 60c.

........: The Public Aquarium. 97 pages, 47 illustrations. 85c.

........: The Fur Seal of the California Islands. 8 pages, 11 text figures, 1 colored plate. 75c.

........: Growth and Age in the Giant Tortoise of the Galàpagos. 8 pages, 13 text figures. 40c.

All these books and others by the same authors may be obtained from the New York Aquarium. The prices include postage.

A classified list of the publications of the Society, with subject headings of articles printed in the *Reports, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. Mitchell, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

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BULLETIN

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SMITHSONIAN INSTITUTION
OCT 11 1935
NATIONAL MUSEUM

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EVER since its founding in 1895 the New York Zoological Society has attracted the active interest of persons who believe, with the founding group, that instruction and entertainment and important scientific achievement can go hand in hand through the maintenance in New York City of well-balanced collections of mammals, reptiles, birds and fishes from all parts of the world.

The Society is taking a prominent part in the conservation of wild life all over the world but especially in North America. The work it has done in the collection of Heads and Horns is of great scientific value, as are the accurate pictures of wild life in its galleries.

In the Society's work of gathering, maintaining and exhibiting its collections, as well as its constant efforts in behalf of conservation of wild life everywhere, every Member shares, and through the privileges of Membership and the Society's publications is rendered an accounting of the work in which he participates.

The New York Zoological Society invites the Membership of all persons who wish to lend financial support to the purposes for which the Society was founded and to cooperate in a tangible way toward the future development of the Zoological Park and the Aquarium.

Annual Membership in the Society is $10, renewable annually. Life Membership may be obtained for $200. A contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

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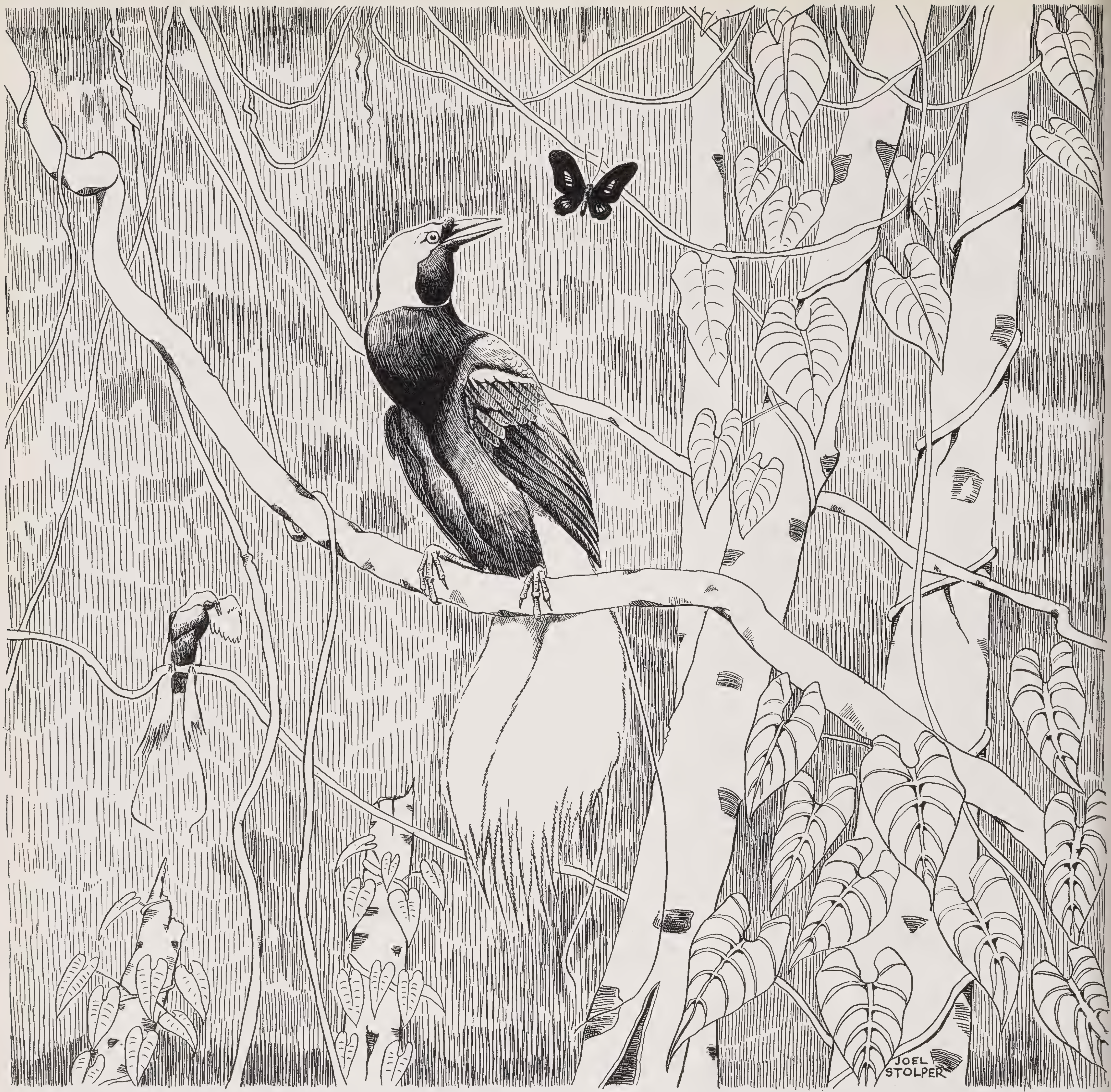
The Zoological Park is open every day in the year from 10 o'clock in the morning to one-half hour before sunset. Admission is free every day except on Mondays and Thursdays when an admission fee of 25 cents is charged for adults and 15 cents for children between the ages of five and twelve. These days have been set aside primarily for the benefit of Members and their friends who are admitted free on tickets issued with Membership, so that the collections may be seen to the best advantage. All holidays are free.

The Aquarium also is open every day in the year. From April 1 to September 30 its hours are 9 o'clock in the morning to 5 o'clock in the afternoon, and for the remainder of the year, from 9 o'clock in the morning to 4 o'clock in the afternoon. No admission is charged.



The Lesser Bird of Paradise

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"The Most Beautiful Birds in the World"

An Account of the Birds of Paradise in Public and Private Collections

LEE S. CRANDALL

PROBABLY no group of birds carries quite the same aura of romance as the birds of paradise. The name alone fires the imagination now, even as it did in the days of its bestowal. The glamor of many fine species is dulled by unfortunate or depressing names but the birds of paradise were happily christened and fully justify the implication.

Birds of paradise appear to have been brought officially to the attention of Europeans on the return on September 6, 1522, of Magellan's globe-circling expedition, though it is possible that the plumes may have been imported previously as ornaments. It is thought[1] that Antonio Pigafetta, historian of the voyage, was the actual possessor of the two skins of the Greater Bird of Paradise (*Paradisaea apoda*) which were the first knowingly to be viewed by Europeans. Pigafetta states[2] that these skins were presented as a gift to the King of Spain by the ruler of Batchian, in the Moluccas, who appears to have been visiting at the small island of Tidore, lying further to the north. The skins must, of course, have been brought from the Arus or even possibly from the mainland of New Guinea, probably in the ordinary course of trade.

Made up in native fashion, lacking both wings and feet, the royal gift made a great impression. The apparent lack of means of locomotion, together with the amazing beauty of the lateral plumes, was a combination which a romantic age could not resist. It was commonly concluded that since the birds were wingless, they could only float in the air, no doubt supported by the trailing plumes. Knowlton[3] quotes the following verse, with no reference to its source:

> "None knowes their nest, none knowes the dam that breeds them.
> Foodless they live; for th'Aire alonely feeds them:
> Wingless they fly; and yet their flight extends,
> Till with their flight, their unknown live's-date ends."

In 1758, when Linnaeus came to give the bird a technical name, complete skins were not yet available, so he called it *Paradisaea apoda,* or "legless" bird of paradise, although he must have known that legs should have been attached to the specimen skins.

Largely through visits to New Guinea by Lesson (1824), Wallace (1856-60) and D'Albertis (1872-77), the true nature of the birds of paradise gradually became known and more and more new forms were revealed, but it was not until 1862 that living birds were seen in Europe. These were two Lessers (*Paradisaea minor*), brought to the Zoological Gardens of London by Alfred Russel Wallace, who had previously failed to land some Red Birds of

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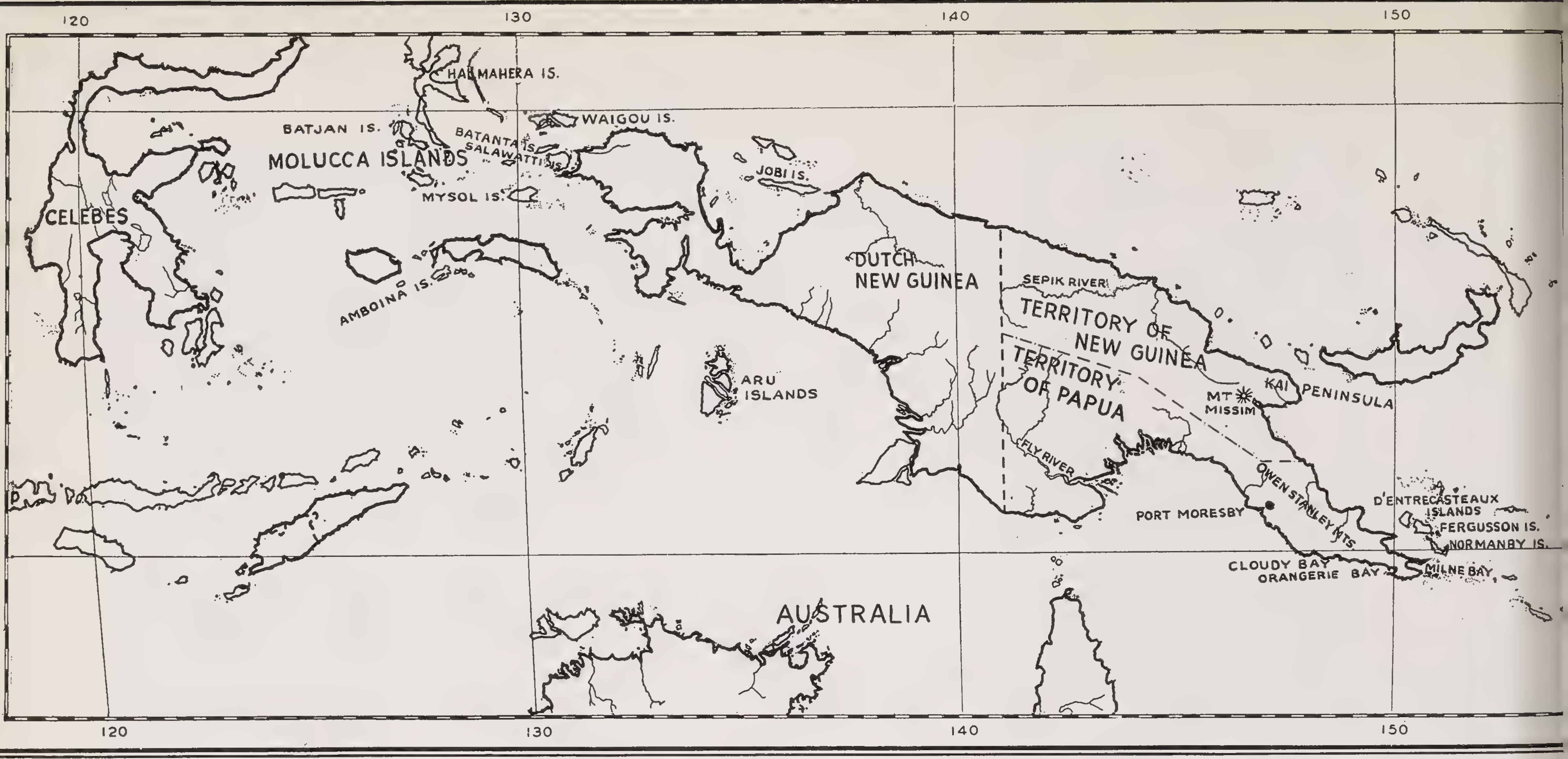
[1] Newton, Alfred. *A Dictionary of Birds,* p. 37.

[2] *Primo Viaggio intorno al Globo,* ed. Amoretti, Milan, 1800, p. 156.

[3] Knowlton, Frank H. *Birds of the World,* 1909, p. 760.



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Paradise (*Uranornis rubra*), with which he had hopefully embarked for England. Occasional birds followed at rather long intervals and it was 1904 before the first real collection was obtained. This included fourteen birds of paradise secured in New Guinea by the resolute collector, Walter Goodfellow, for Mrs. Johnstone, a well-known English aviculturist.

The success of this venture so far exceeded expectations that great enthusiasm was aroused. Several expeditions were equipped by wealthy amateurs and some really fine collections were gathered. At Hoddam Castle, N. B., Mr. E. J. Brook is said to have housed, in 1910, no less than nineteen species of birds of paradise.[4] No complete list seems to have been published and there is likelihood that some of the bowerbirds may have been included. Whether or not this is true, the collection was by far the largest ever gathered by a private aviculturist and may quite possibly have exceeded the exhibits of any zoological institution.

It was in Mr. Brook's aviaries that the first recorded attempt at breeding in captivity was made by birds of paradise. A pair of Princess Stephanie's (*Astrapia stephani*) nested three times, laying a single egg on each occasion.[5] Since the egg was unknown, these were preserved and not incubated. It might be noted in passing that no bird of paradise has yet been bred in captivity—at least, as far as the records go. A pair of Kings (*Cicinnurus regius*) in the Zoological Gardens at Batavia, Java, hatched young which perished in the nest. Even this effort was not fruitless, however, for the birds were observed to nest in a hollow in a tree, a habit not previously recorded for any bird of paradise.[6]

In the more than twenty years that have elapsed since the outbreak of the World War, no private aviarist has arisen to take full possession of the place once occupied by Mr. Brook. In fact, restrictive laws controlling the export of birds from both the British and Dutch divisions of New Guinea have made it practically impossible for any but accredited institutions to secure permits to collect them. Consequently but few birds have been available in recent years, these being obtained chiefly by the British collectors, F. Shaw Mayer and W. J. C. Frost. Few institutions at present enjoy a financial position which enables them to equip expeditions so costly and so likely to be meagre or negative in results. No other official effort of the same status has been made since the New York Zoological Society's successful New Guinea Expedition in 1928-9.[7] All things considered, it is probable that birds of paradise will continue to be among the great rarities in both public and private collections.

The excitement aroused by the appearance of skins of birds of paradise in Europe more than four hundred years ago has never quite subsided. There seem to be two principal reasons for this sustained attraction. These are the intrinsic beauty of the birds themselves, and the fact that New Guinea, center of distribution of the group, remains one of the least-explored spots on the globe. Physically much is now known of the numerous forms and their distribution, but largely because of the difficulties of exploration in New Guinea knowledge of their lives and habits has advanced but little. Even the nest and eggs of many species are still unknown, and most of the male courtship displays that have been described were observed in captive birds.[8] Fortunately, most of the species are still abundant in their remote haunts and are fully protected, at least under British control, from plume hunters, and are but little affected by native feather requirements. In most sections these conditions are likely to remain unchanged for many years, so that there is reason to hope that some day the secrets of the lives of the birds of paradise may be thoroughly worked out.

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[4] Goodfellow, Walter. *Avicultural Magazine*, Third Series, Vol. I, p. 277.

[5] Seth-Smith, D. *Aviculture*, Vol. I, 1925, p. 26.

[6] Frost, W. J. C. *Avicultural Magazine*, Fifth Series, Vol. VIII, No. 2, 1930, pp. 33-35.

[7] Bulletin, Vol. XXXII, No. 6, 1929, pp. 215-255.

At one time the birds of paradise were considered to be delicate in captivity. Under modern methods of treatment, however, they have been found to thrive for reasonably long periods, a Twelve-wired (*Seleucides melanoleucus*) having lived for thirteen years in the Zoological Gardens of London.[9] Most of the birds in our own collection have been here since the return of the New Guinea Expedition in March, 1929, and the latest acquisitions were received in the spring of 1932. It is fortunate, indeed, that these splendid birds are capable of a long span of life under our conditions, for when it is ended, replacements are not easily made.

While most of the birds of paradise are found on the mainland of New Guinea, a few forms live on small neighboring islands—the Arus, Jobi, Mysol, Waigou, Salawatti, the Moluccas, the D'Entrecasteaux—and in Australia. In systematically arranging the species, it has been customary to include most of them in the family Paradisaeidae, with a few, such as the Six-plumes (*Parotia*) and the Superbs (*Lophorina*), assigned to the Ptilonorhynchidae (Bower-birds). The distinction between these families is not clearly cut and there is now a tendency toward uniting them. In any case, the number of forms known as birds of paradise, whether considered in one family or in two, is something over eighty. If the bower-birds and cat-birds are included, the total is increased by about thirty-five forms.

In addition to the accepted species and subspecies of the birds of paradise, at least eighteen have been described which are now regarded as hybrids or artifacts.[10] The latter—skins made up from parts of different birds—were once not uncommon in the trade. It is strange that birds of such restricted range and specialized plumage should hybridize with what seems to be some frequency. But skins of the bird known as *Rhipidornis guilelmi-tertii,* which is not especially rare, are plainly seen to represent hybrids between a Magnificent (*Diphyllodes*) and a King (*Cicinnurus*).

So far, fewer than thirty forms of the birds of paradise appear to have been kept in captivity. Of these, twenty-two have been exhibited in the New York Zoological Park. At the present time (August, 1935) we number sixteen, two less than our maximum total. These are as follows: (Star indicates now living)

Magnificent Rifle Bird, *Craspedophora magnifica intercedens* (Sharpe).
*Twelve-wired Bird of Paradise, *Seleucides melanoleucus melanoleucus* (Daudin).
*Long-tailed Bird of Paradise, *Epimachus meyeri meyeri* Finsch.
*Lord Rothschild's Gorgetted Bird of Paradise, *Astrapia rothschildi* Foerster.
*Greater Bird of Paradise, *Paradisaea apoda apoda* Linnaeus.
*Count Salvadori's Bird of Paradise, *Paradisaea apoda salvadorii* Mayr and Rand.
*Lesser Bird of Paradise, *Paradisaea minor minor* Shaw.
*Emperor of Germany's Bird of Paradise, *Paradisaea guilelmi* Cabanis.
*Red Bird of Paradise, *Uranornis rubra* (Daudin).
*Prince Rudolph's Blue Bird of Paradise, *Paradisornis rudolphi rudolphi* Finsch.
King Bird of Paradise, *Cicinnurus regius* (Linn.).

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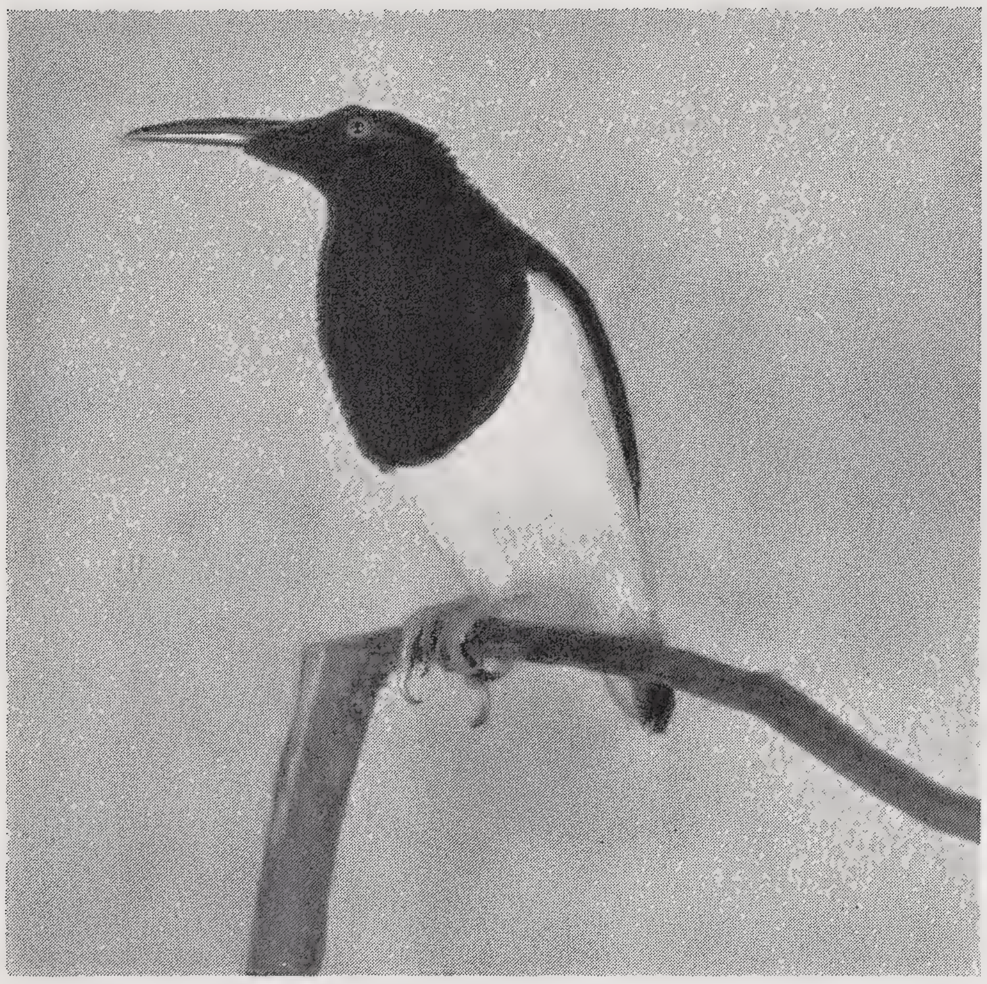
[8] Zoologica, Vol. XI, No. 7, pp. 77-87.

[9] Seth-Smith, D. *Aviculture*, Vol. I, 1925, p. 25.

[10] Stresemann, Edwin. *Novitates Zoologicae*, Vol. XXXVI, No. 1, 1930, pp. 6-15.



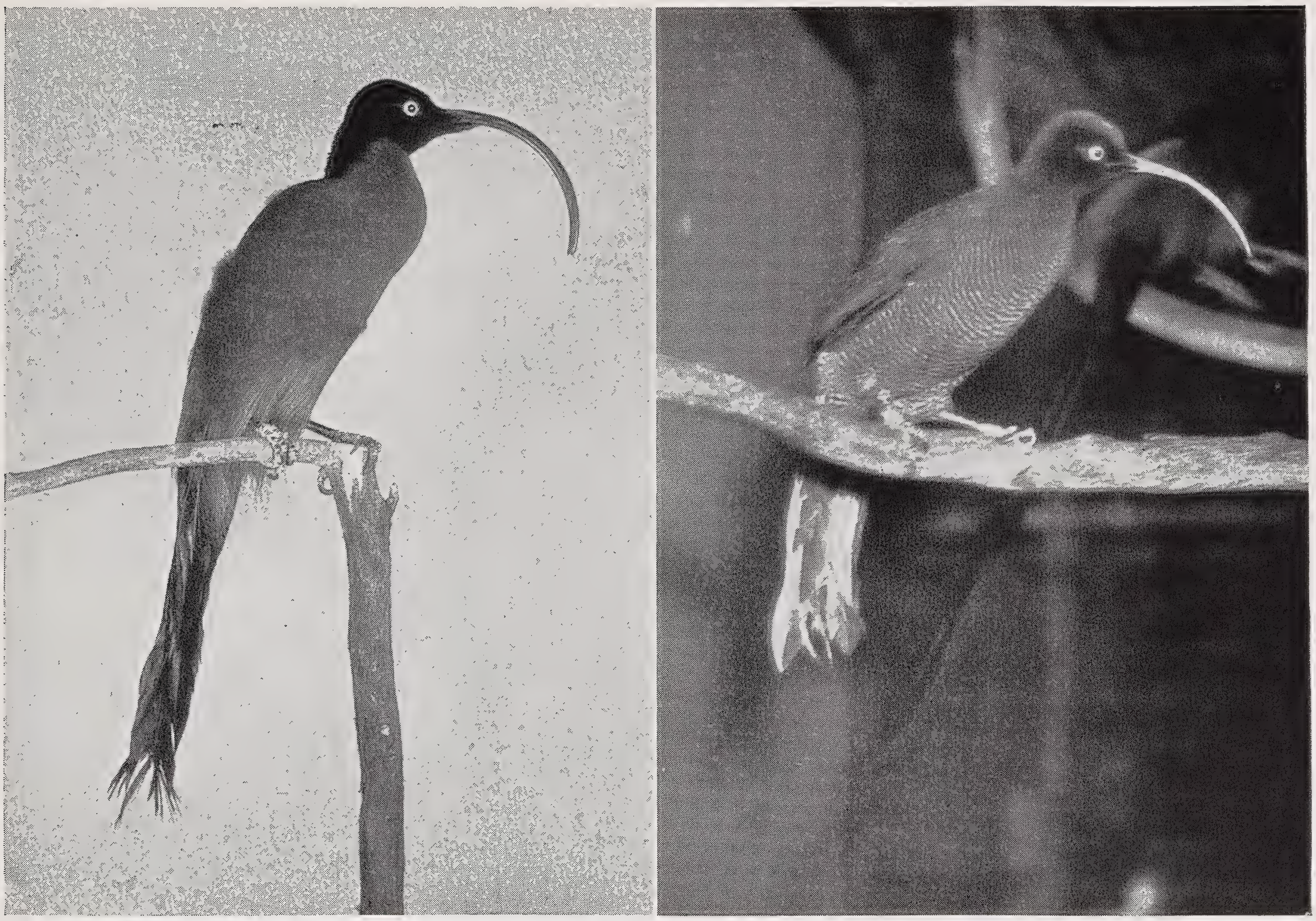
The Twelve-wired Bird of Paradise is a low-land species from the swampy jungles of New Guinea and Salawatti.

Magnificent Bird of Paradise, *Diphyllodes magnificus magnificus* (Pennant).
*Hunstein's Magnificent Bird of Paradise, *Diphyllodes magnificus hunsteini* Meyer.
Wilson's Bird of Paradise, *Schlegelia respublica* (Bonaparte).
*Wallace's Standard-winged Bird of Paradise, *Semioptera wallacii wallacii* (Gray).
*Blue Manucode, *Manucodia chalybatus orientalis* Salvadori.
Green Manucode, *Manucodia ater subalter* Rothschild and Hartert.
*James's Horned Manucode, *Phonygammus keraudrenii jamesi* Sharpe.
*Greater Six-plumed Bird of Paradise, *Parotia sefilata* (Pennant).
*Lawes's Six-plumed Bird of Paradise, *Parotia lawesi lawesi* Ramsay.
*Lesser Superb Bird of Paradise, *Lophorina superba minor* Ramsay.
Long-plumed Superb Bird of Paradise, *Lophorina superba latipennis* Rothschild.

Among the rifle birds, the males are chiefly black, relieved by intensely brilliant areas of metallic greens, purples and blues. The flanks bear comparatively short ornamental plumes. They are assigned to two genera, *Ptilorhis* and *Craspedophora,* the former confined to Australia and the latter with forms in both Australia and New Guinea. The Australian Rifle Bird (*Ptilorhis paradiseus*) has been kept in Europe, but only one of the New Guinea birds (*Craspedophora magnifica intercedens*) seems to have been imported into America. This subspecies is abundant in the Central Division of the Territory of Papua, at elevations up to about 3,000 feet. Because of the impossibility of making a stop at the proper altitude, no specimens were secured by the Society's New Guinea Expedition, but the bird was frequently seen and heard. The name is said to have been derived from the resemblance of the plumage to the uniforms of British rifle regiments. It certainly has no connection with the voice, which is a loud and easily imitated "cra! cra!"

The Twelve-wired Bird of Paradise (*Seleucides melanoleucus*) is a low-land species, found in swampy jungles and usually associated with the sago palm. Two subspecies, rather doubtfully distinct, are recognized: *S. m. melanoleucus,* from most of New Guinea and Salawatti, and *S. m. auripennis,* from northern New Guinea. It is probable that both forms have been kept in collections. The male is a handsome bird, black with a largely purple gloss above, the throat and chest also black but with a green iridescence and edged with a narrow band of emerald. The remainder of the lower surface is bright yellow, the feathers of the flanks being drawn out into rather short ornamental plumes. The strong yellow of the under parts is not reproduced in captivity but is replaced by a paler shade which sometimes approaches white. The bird's name is derived from twelve delicate, bare shafts which extend along the flanks, six on each side, and recurve at a sharp angle over the back.

D'Albertis's Bird of Paradise (*Drepanornis albertisi*) is one of the most interesting species, found only at high altitudes. Three forms are usually recognized: *D. a. albertisi,* from northwestern New Guinea; *D. a. geisleri,* from the north; and *D. a. cervinicauda,* from the southeast. The latter was included in the Brook collection and a specimen of *geisleri* was brought to the Zoological Gardens of London in 1931 by F. Shaw Mayer. The typical form does not seem to have been taken alive. The species is quite small, chiefly brownish in general coloration, the lower surface glossed with purple. At each side of the upper breast there is a tuft of



The largest birds of paradise are the Long-tails inhabiting the high, thick forests of New Guinea. The first specimen was brought out in 1909 *and no others seem to have been exhibited until the New York Zoological Society expedition landed two in* 1929.

purple, edged with orange. Below these another pair arises, very much broader and longer, chocolate in color, glossed with purple and edged with amethyst. The beak is very long and sharply decurved. *Drepanornis bruijni,* another member of this genus from northern New Guinea, probably has never been exported alive.

The Long-tailed Birds of Paradise (*Epimachus*) are the largest of the group. They are now considered as two species, *fastosus* and *meyeri,* each further divided into subspecies. The forms of *fastosus* have the breast black or very dark brown, while those of *meyeri* are olive brown below, washed with lilac. All are inhabitants of the heavy forests at high elevations on the New Guinea mainland.

The Long-tails were sought industriously for years, but up to 1909 without result. In that year Walter Goodfellow obtained specimens of *E. m. meyeri* for Mr. Brook. What became of these birds or what success was met in keeping them alive is not a matter of record. No further importations appear to have been made until 1929 when the Society's expedition landed an immature pair in New York. The female met an untimely end in 1935 through getting her feet entangled in the wire mesh of her aviary. The male, which at this date (August, 1935) is still living, eventually assumed the full magnificence of adult plumage.[11] This is black above, with patches of metallic blue on the head and back. The lower parts are a rather mousy olive-brown, relieved by delicate reflections of lilac. The flanks bear short, straggly plumes of the same color. At each side of the upper breast is a large velvety black fan, erected only during display and kept tucked out of sight while the bird conducts its ordinary affairs. The tail, as indicated, is very long, tapering to a thin point. It is difficult to secure length measurements of living birds, but the skin of an

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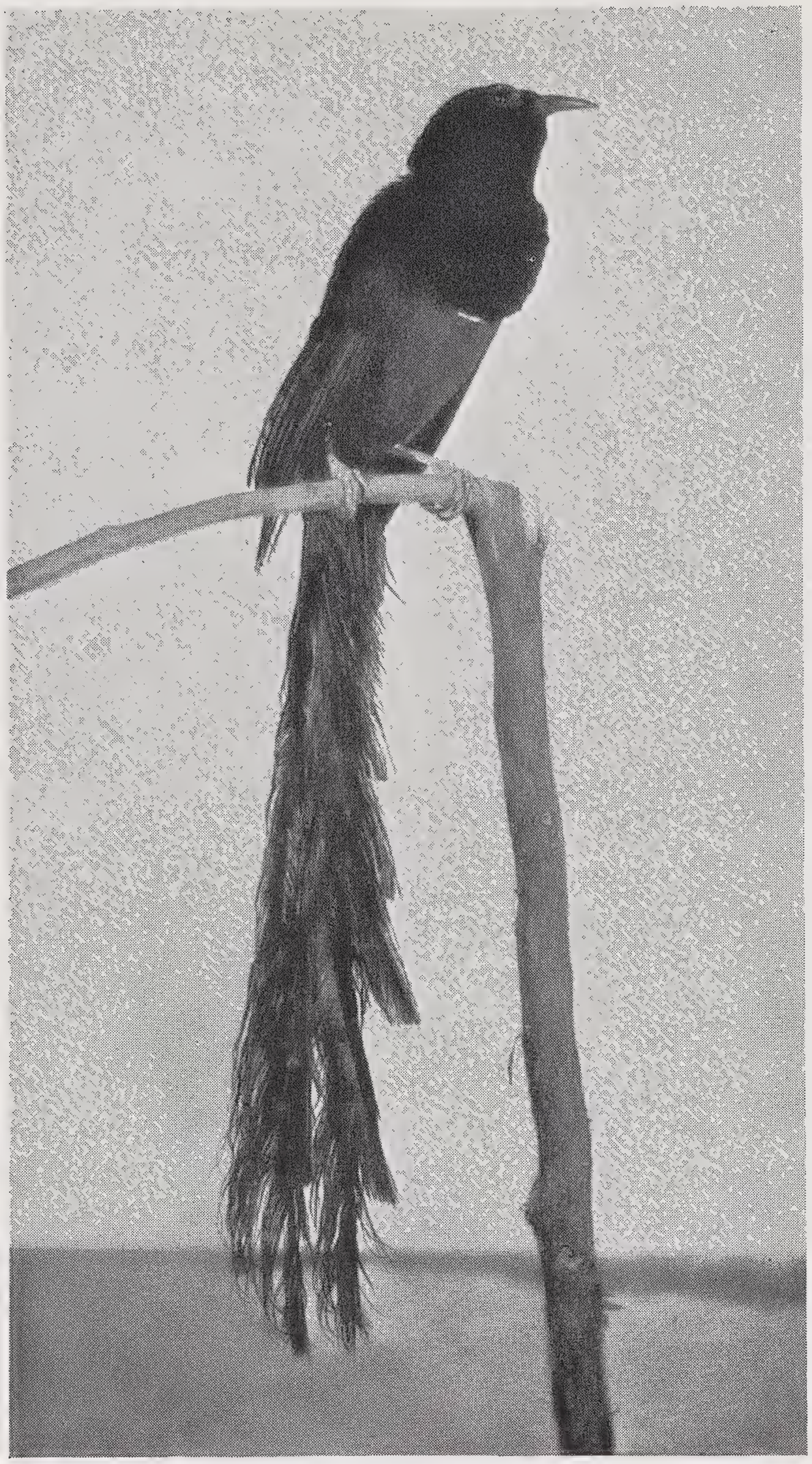
[11] Zoologica, Vol. XI, No. 7, 1932, pp. 82-84.



Lord Rothschild's Gorgetted Bird of Paradise, from the Kai peninsula, has been seen in captivity only since 1931.

adult male in the museum at Sydney, Australia, extended forty-two inches from the tip of the deeply curved beak to the end of the tail.

The Gorgetted Birds of Paradise (*Astrapia*) are of medium body size and have shorter beaks than the preceding species. They are characterized by very long, broad tails. There are three well-known species: *A. nigra,* from northwestern New Guinea; *A. rothschildi,* from the northeast; and *A. stephani,* of which the typical form is found in the southeast, with *A. s. feminina* in the northeast. The males of all are black in general, with iridescent nuchal ruffs and breastplates.

There are records of only two of these birds having been kept alive. Princess Stephanie's Bird of Paradise (*A. s. stephani*) was brought out in 1909 by Mr. Goodfellow for Mr. Brook, in whose aviaries it attempted to breed, as related above. Lord Rothschild's Gorgetted Bird of Paradise (*A. rothschildi*) was unknown to aviculture until 1931 when a number of specimens secured in the Kai peninsula, northeastern New Guinea, by F. Shaw Mayer, were landed in England. Three males from this lot were added to our collection.

The typical birds of paradise (*Paradisaea*) are well known as the bearers of the lovely plumes popular as head-dress ornaments from very early times. Their importation into America is now prohibited by law and their exportation from the British sections of New Guinea is also illegal. In Dutch New Guinea and the islands under the same control, all birds of paradise are rigidly protected with the exception of the *gele* species—specified among the Colonial regulations as *Paradisea apoda* and *minor.* The plumes of these birds are still exported under regulation of the Government of the Western Provinces, acting from Amboina.

The Greater Bird of Paradise (*P. apoda apoda*) from the Aru Islands, which lie southeast of the New Guinea mainland, is probably the best known of the entire group. It is a large and splendid bird, the male bright reddish-brown in general, with the crown and nape bright yellow and the forehead, cheeks and throat metallic green. The ornamental plumes spring from the flanks, just below the shoulders, and are deep yellow for the basal two-thirds, then changing to pale brown. The two central tail feathers, known as "wires," have become denuded of barbs and greatly lengthened, sometimes extending as much as thirty inches.

The mainland Greater (*P. a. novaeguinae*) is found in the southwestern section, extending east to the Fly River. It is a smaller bird and there is no record of its having been imported alive, although specimens might readily be confused with the Aru form.

Between these birds and Count Raggi's Bird of Paradise (*P. a. raggiana*) of southeastern New Guinea, which has dark red plumes, lies a series of several connecting forms with plumes of various shades of reddish-orange. The only

This wild and broken country gives some idea why collecting expeditions in New Guinea are costly and uncertain of results. Mount Iola, in the foreground, is part of the Owen Stanley Range that runs through the heart of the bird of paradise country.

one of these that has been recorded in captivity is the Empress Augusta Victoria's Bird of Paradise (*P. a. augustae-victoriae*), of which a fine male example was brought to the Zoological Gardens of London by F. Shaw Mayer in 1931.

The range of Count Raggi's Bird of Paradise has been considered as extending from just west of the Fly River along the south coast of New Guinea to Milne Bay, at the southeastern end of the island. However, the bird from the western portion of this area, from just west of the Fly River eastward to Cloudy Bay, has recently been separated as *Paradisaea apoda salvadorii,*[12] or Count Salvadori's Bird of Paradise. The principal difference in the new bird is the lack of yellow mottling on the back of the male. Count Raggi's Bird of Paradise will now be restricted to the district between Cloudy and Milne Bays. It is probable that the true Count Raggi's, as now defined, has never been seen in captivity and that living specimens so named must be referred to *P. a. salvadorii.*

Count Salvadori's is the typical plumed bird of paradise of the Central Division. It ranges from the lowest foothills upward probably to 5,000 feet and within its territory one is seldom out of ear-shot of its reverberating calls. This fine bird was once greatly persecuted by plume hunters but official vigilance is now so alert that it is unlikely that smuggling of any consequence is carried on. As it would be even more difficult to secure living specimens without official sanction, Count Salvadori's has become rare in collections. It is quite possible that our fine male, brought here in 1929, may be the only specimen now in captivity.

The Lesser Bird of Paradise (*P. minor*) is second only to the Greater in popular acquaintance. The male is similar in a general way to the larger bird, differing in its smaller size, in having the yellow of the nape extended to the mantle and the long, yellow ornamental plumes tipped with white instead of brown. Once probably the least common of a group rare in captivity, the Lesser is nowadays practically as difficult to obtain as most others.

The typical form of this bird (*P. m. minor*) from northwestern New Guinea and Mysol, is

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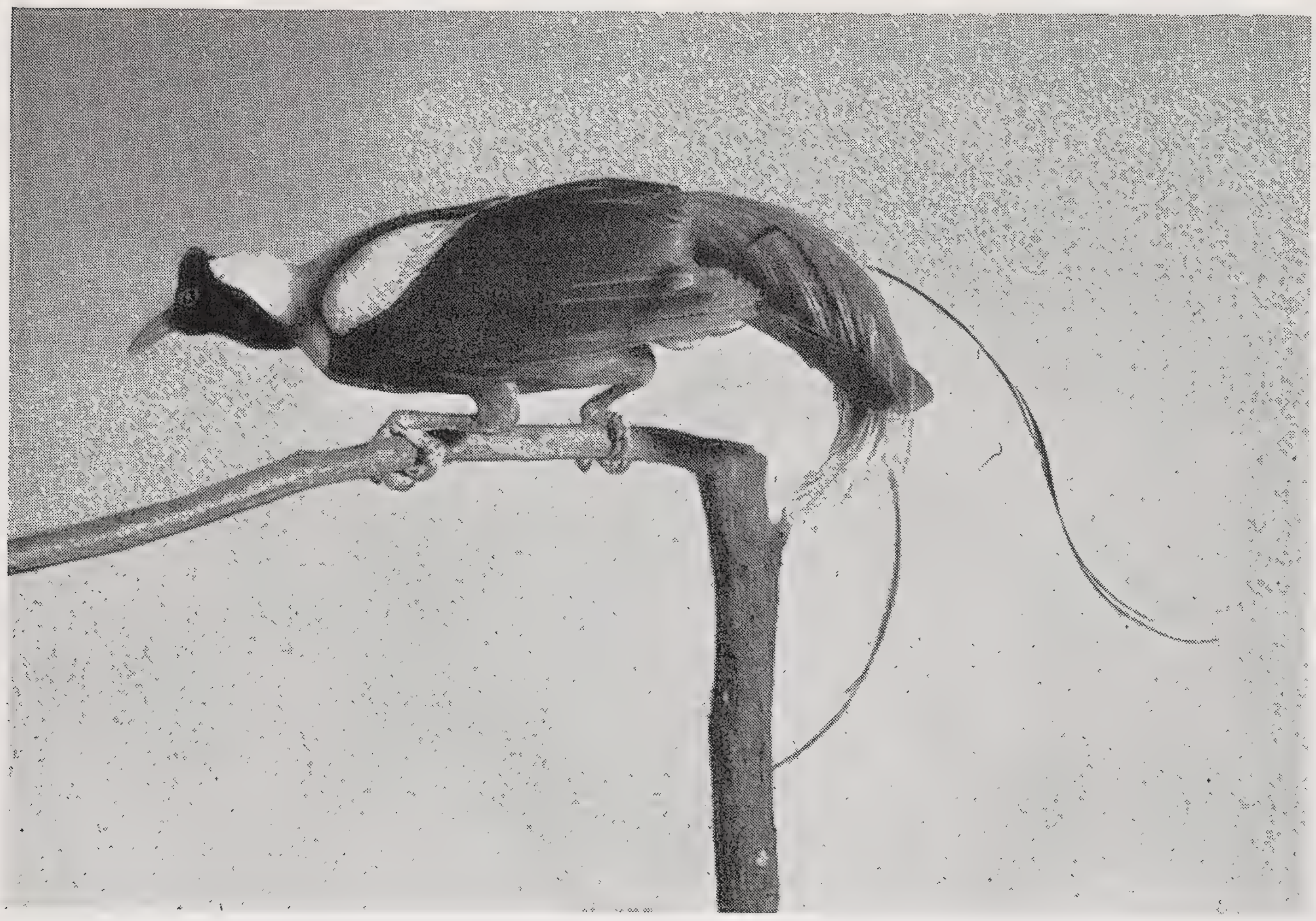
[12] Mayr, Ernst and Rand, A. L. Results of the Archbold Expeditions. No. 6. *Am. Mus. Novitates,* No. 814, Aug. 1, 1935, pp. 11-12

Three representatives of the typical birds of paradise:

(Left) the Greater.

(Lower left) Count Salvadori's, possibly the only specimen now in captivity.

(Lower right) the Lesser.



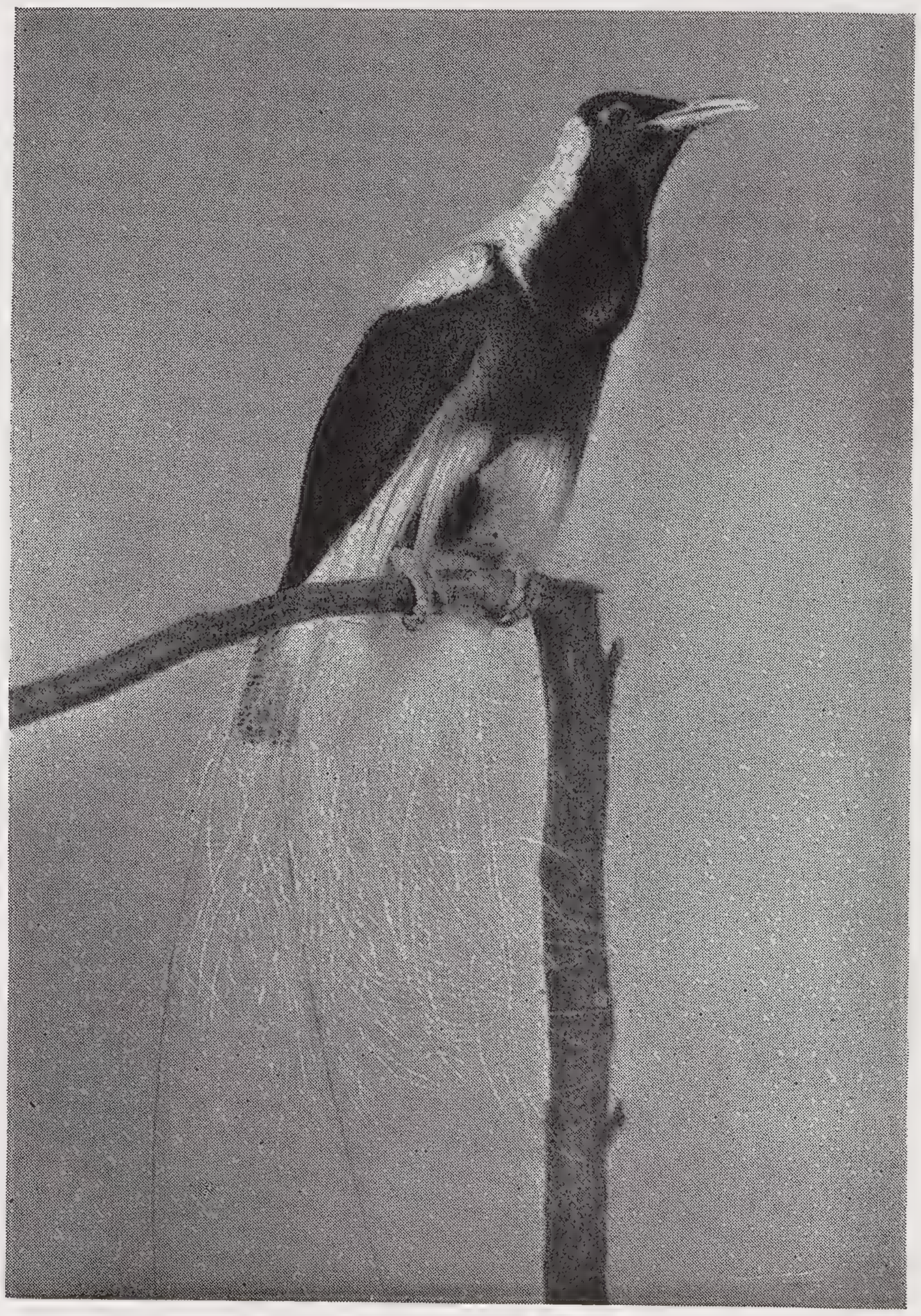
The Red Bird of Paradise from Waigou Island is frequently seen in collections but is rather hard to keep in captivity.

the only one which has been recorded in captivity. It may be, however, that both *P. m. jobiensis,* from Jobi, and *P. m. finschi* (which has the plumes dark-tipped as in *apoda*), from northeastern New Guinea, have been imported and escaped notice, since the subspecific differences are slight.

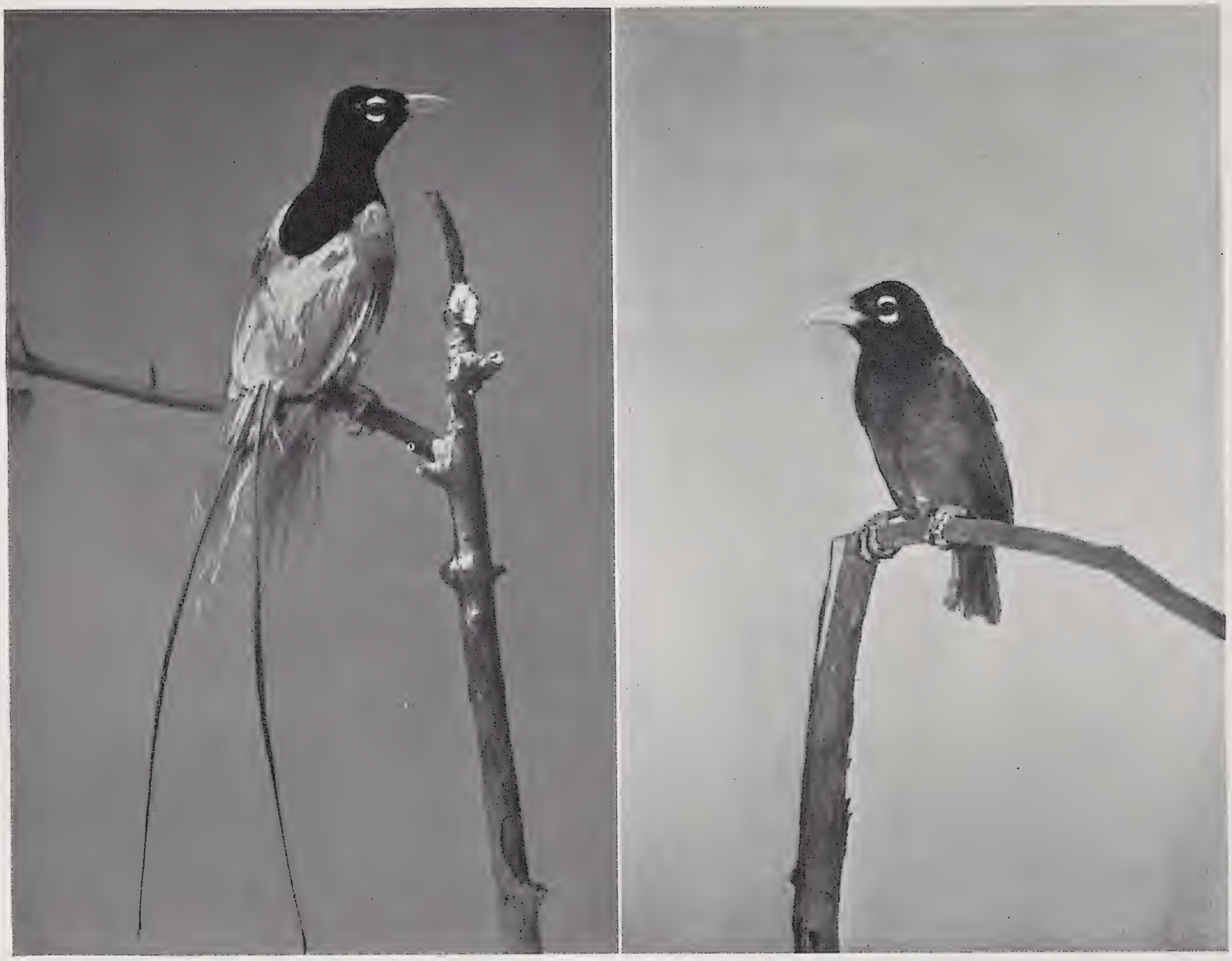
The Emperor of Germany's Bird of Paradise (*P. guilelmi*) was not seen in collections until it was brought from northeastern New Guinea by F. Shaw Mayer in his 1931 collection. Two fine males from this importation were secured for our series. This rare bird is similar, in general, to other members of the genus but differs in having the green of the head and breast more extensive, and in the formation of the white ornamental plumes. In these, the barbs are long and widely spaced, giving the feathers a delicate and ethereal appearance.

One of the very finest of all the birds of paradise, not yet seen in captivity, should be mentioned here. It is the Gray-chested (*P. decora*), from Fergusson and Normanby Islands in the D'Entrecasteaux group, off the southeastern tip of New Guinea. This bird's most striking feature is the ornamental plumes, which are deep red in color and of the same disintegrated type seen in the Emperor of Germany's Bird of Paradise. The hostility and bad reputation of the natives have no doubt hitherto discouraged collectors, but risks as great have been taken for birds of less desirability.

The Red Bird of Paradise (*Uranornis rubra*), from Waigou, differs from the forms of *Paradisaea* in several important respects. The feathers of the head are raised above the eyes in two low, horn-like projections; the red, white-tipped ornamental plumes are short, stiff and curved forward at the ends; the tail wires are flattened and broad, like narrow strips of metal ribbon and twist in a graceful spiral. This bird is seen in collections with some frequency but is perhaps more difficult to keep than many others.



The Emperor of Germany's Bird of Paradise is one of the rarer species and was unknown to aviculturists until 1931.



The most beautiful of all the birds of paradise is probably Prince Rudolph's Blue, once vigorously sought by plume hunters but now strictly protected not only by law but by the reluctance of the natives to catch it. This is a pair, the male at the left.

Prince Rudolph's Blue Bird of Paradise (*Paradisornis rudolphi rudolphi*) is one of the most beautiful of the group. No doubt its color has an important bearing here, for blue is scarce among the birds of paradise. It is found at 6,000 feet and above in the Owen Stanley Range of southeastern New Guinea. A second form, differing chiefly in the coloration of the head, has recently been described as *Paradisea* (*Paradisornis*) *rudolphi ampla*,[13] from Mount Missim in northeastern New Guinea.

The Blue Bird of Paradise possesses an intangible beauty that arouses a sense of complete futility when a description must be written. It is always tempting to try to translate the effect of living, shimmering blues and deep, velvet black but, perhaps because the impression itself is too delicate to grasp, this invariably degenerates into mere sentimentality. So no doubt the cut-and-dried form of description is still best: head, breast and back, black; wings and tail blue; a short white line above and below each eye. The plumes, which are rather short and seen to advantage only in display, are blue on one side and pale brownish-mauve on the other. The tail wires are very long and narrow and each ends in a small rounded tab.

The Blue Bird of Paradise has always been one of the great objectives of the aviculturist, but very few have been secured alive. Probably John Ward of Sydney, main-stay of our New Guinea Expedition, has brought out more specimens than any other collector. This species was once a great victim of plume hunters. The native rulers of India were especially keen for them and it is said that as much as £25 was fetched by a good skin. The bird is still fairly abundant in its remote mountain fastnesses but will certainly remain very rare in captivity, for the natives display a curious reluctance to catch it.

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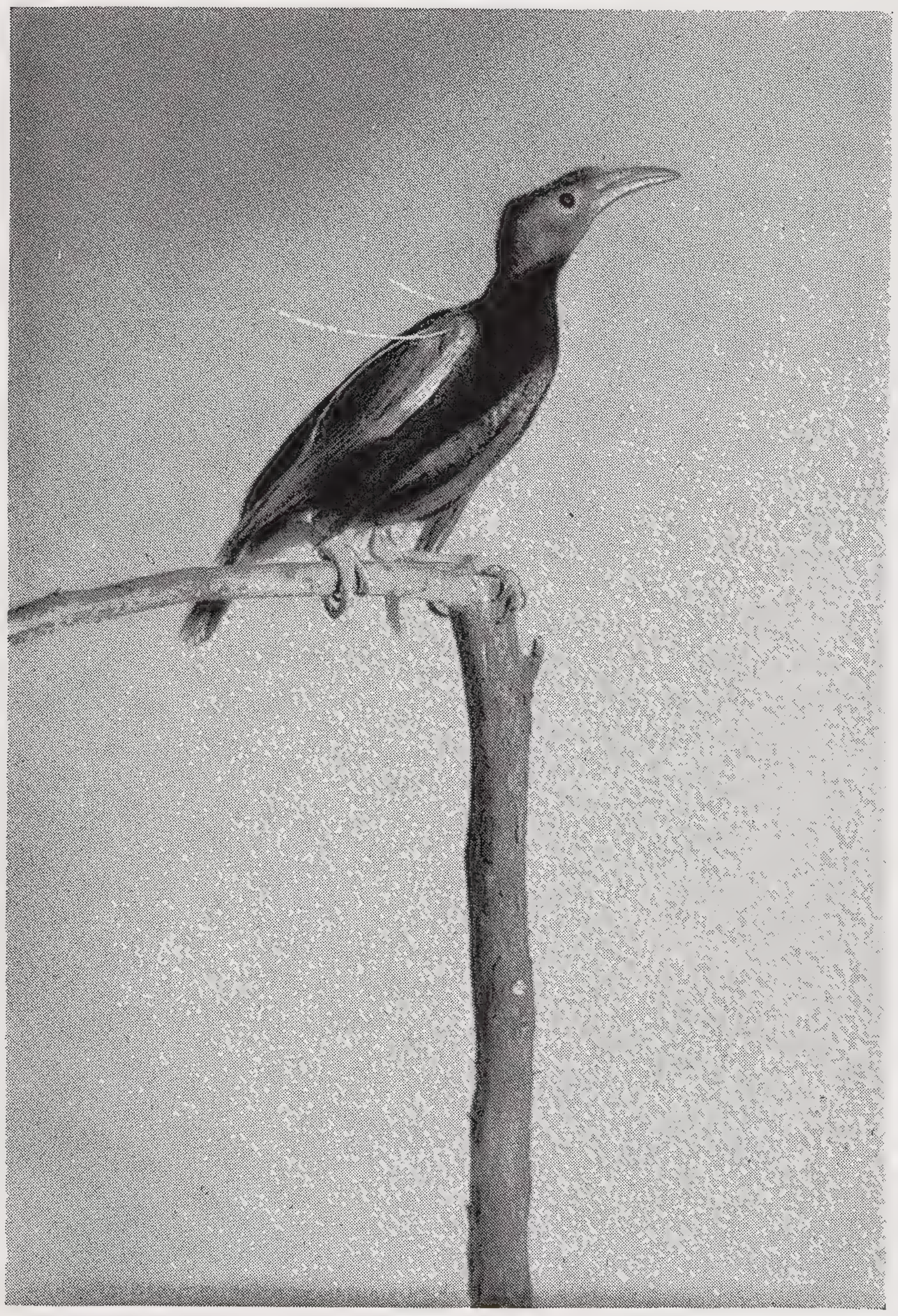
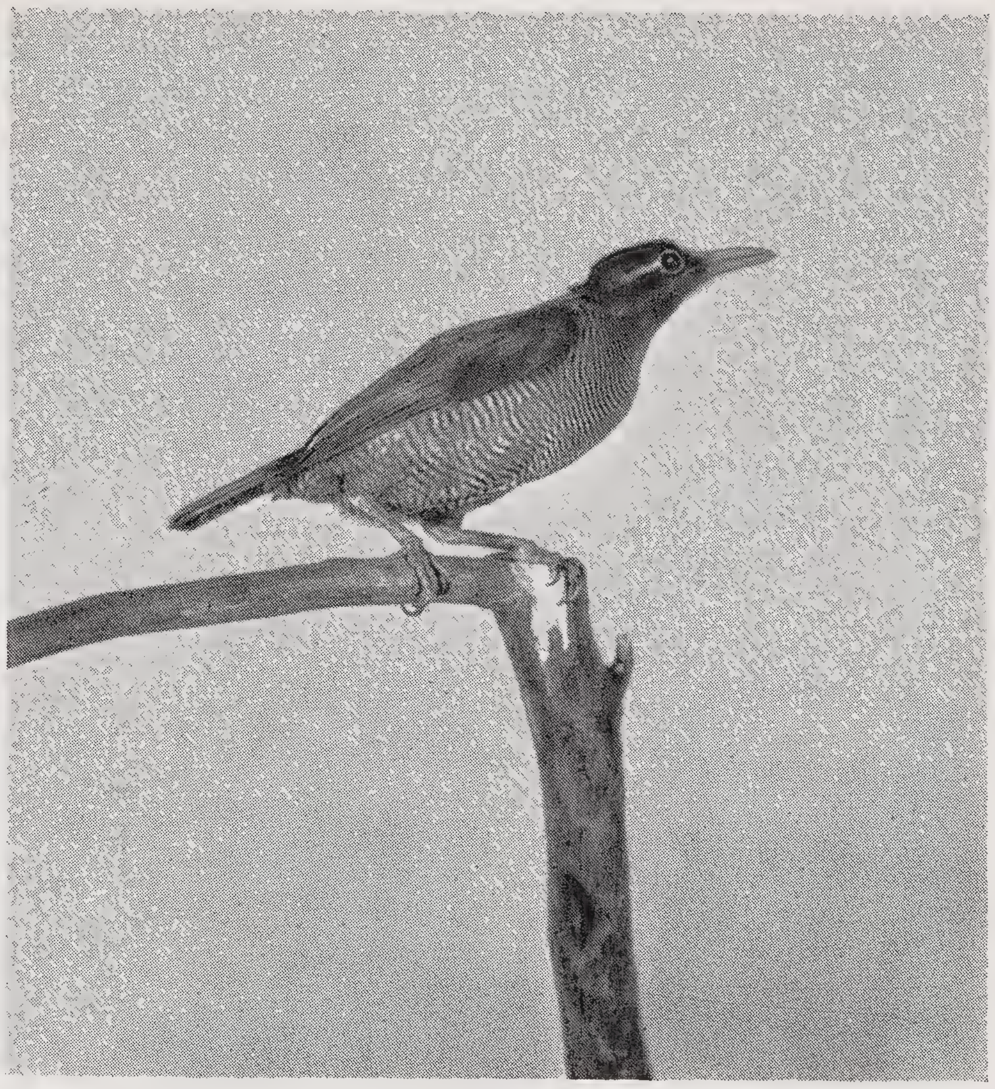
[13] Greenway, James C., Jr. *Proc. New Eng. Zool. Club*, Vol. XIV, 1934, p. 1.

One of the smallest of the birds of paradise, as well as one of the most brightly colored, is the King (*Cicinnurus regius*). The chest and abdomen are silky white, with the upper surface and the throat brilliant scarlet. There is a small, pale gray fan, tipped with green, at each side of the breast. The two tail wires are about six inches long, feathered on one side only of the tip, which is recurved in an enamel-like green disk. Six subspecies are usually recognized, ranging from the typical form in the Arus, through several other neighboring islands and most of the mainland. This is a bird of the foothills and in the Central Division of Papua, at least, is not seen much above 3,000 feet.



Wallace's Standard-winged Bird of Paradise is "a curious rather than a beautiful bird," first described in 1859.

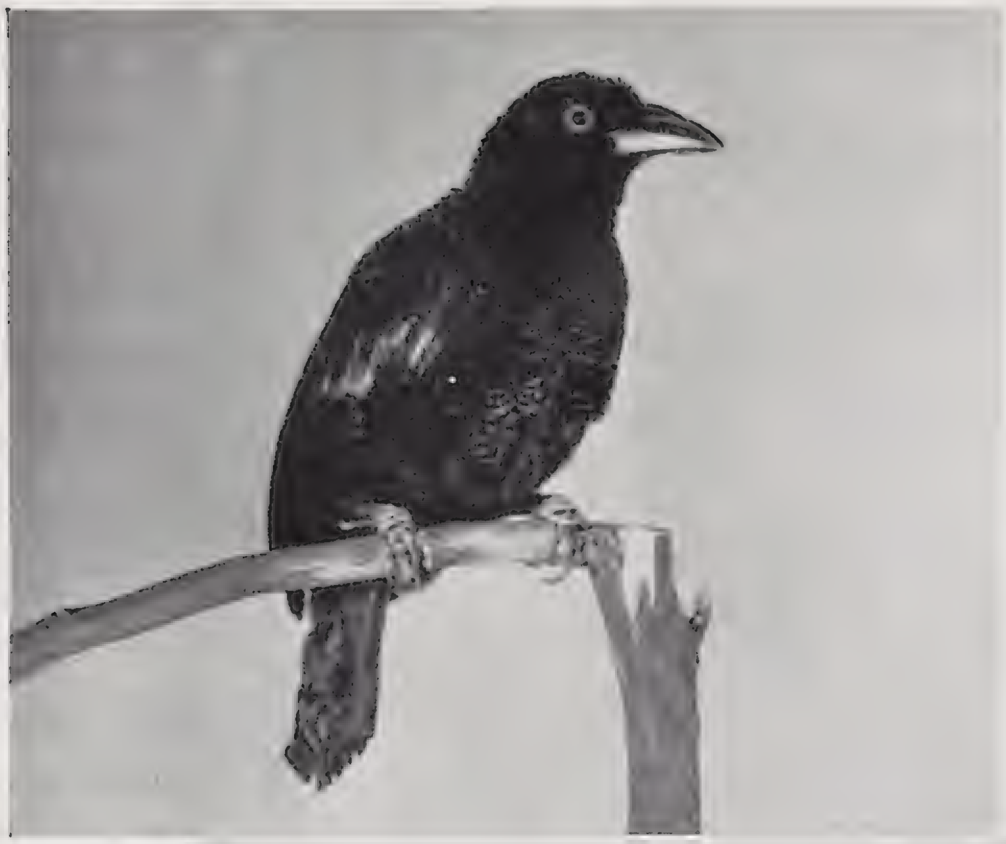


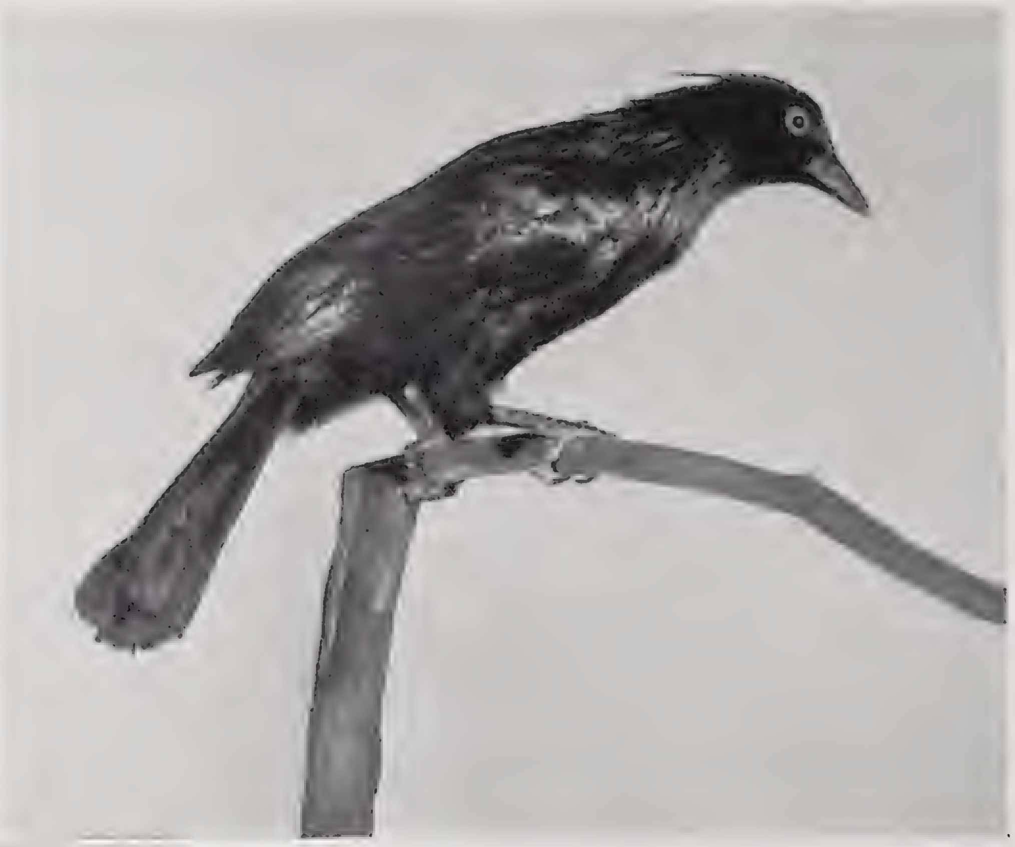
Hunstein's Magnificent Bird of Paradise is a small species from the mountain districts. This specimen is a hen.

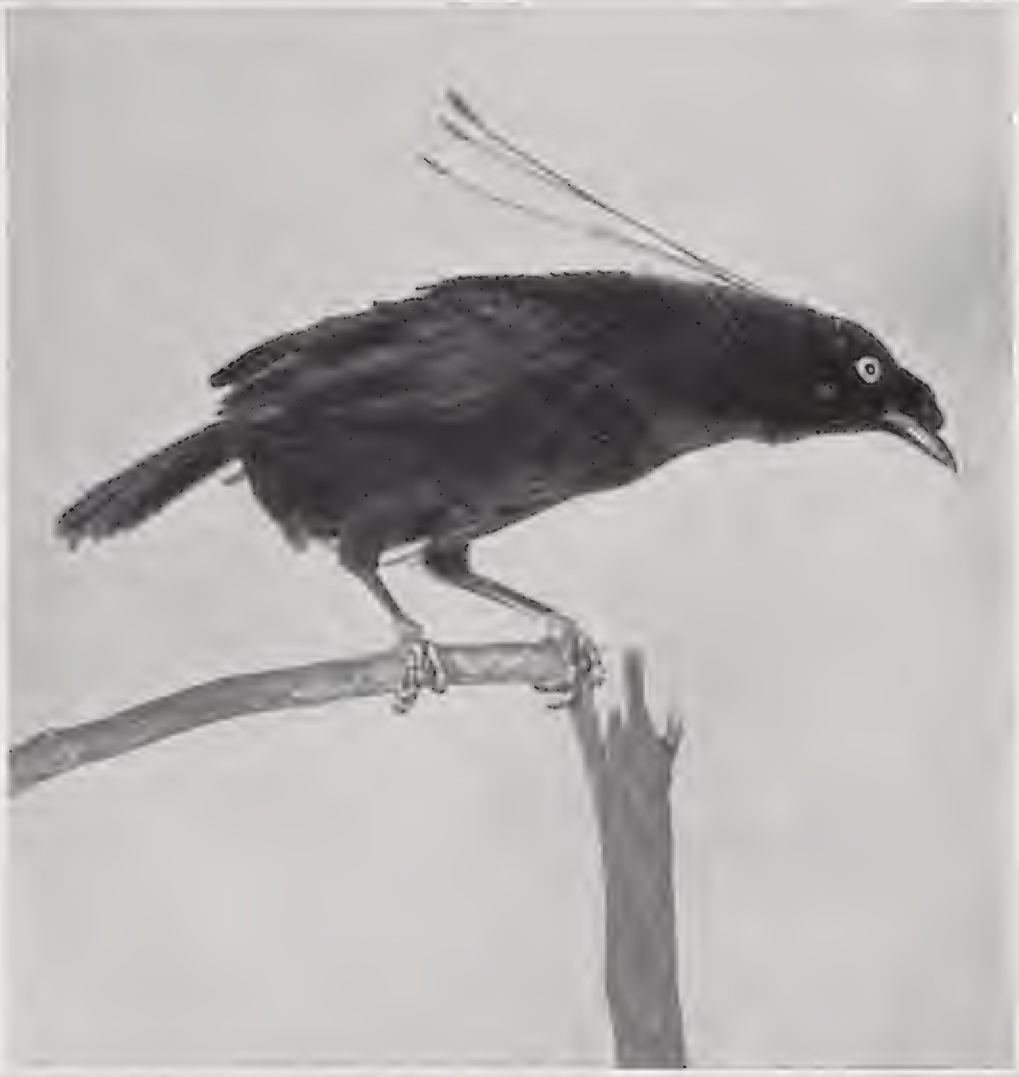
The Magnificent Bird of Paradise (*Diphyllodes magnificus*), while larger than the King, is still among the smaller species. On close inspection the upper surface of the male seems slightly jumbled, but the general effect is very beautiful. The head and neck are brown, with a wide cape of bright yellow expanding from the lower part of the neck. The back is a mixture of dull reddish-browns, while the coverts of the wing are orange or yellow, varying in the different forms. The breast is a lustrous, velvety green. The tail wires are recurved in twin semicircles.

The Magnificent is abundant in the mountain districts, living at the middle heights, from 2,000 to 5,000 feet. There appear to be at least four tenable forms, covering most of the New Guinea mainland, Salawatti and Jobi.

Wilson's Bird of Paradse (*Schlegelia respublica*), from Waigou and Batanta, was first introduced to aviculture in 1915 by Mr. A. E. Pratt. Two birds from that shipment, together with two Red Birds of Paradise, were added to our collection. The Wilson is hardly larger than the King, but bears some resemblance to the







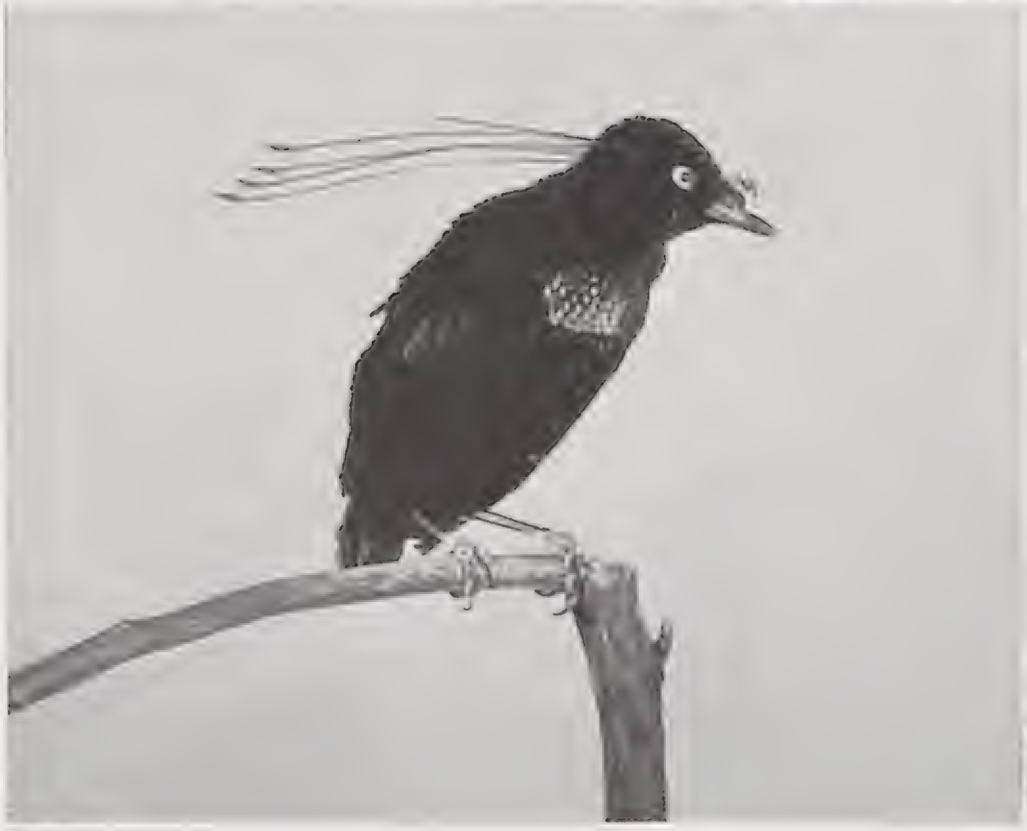
(Upper left) Blue Manucode.

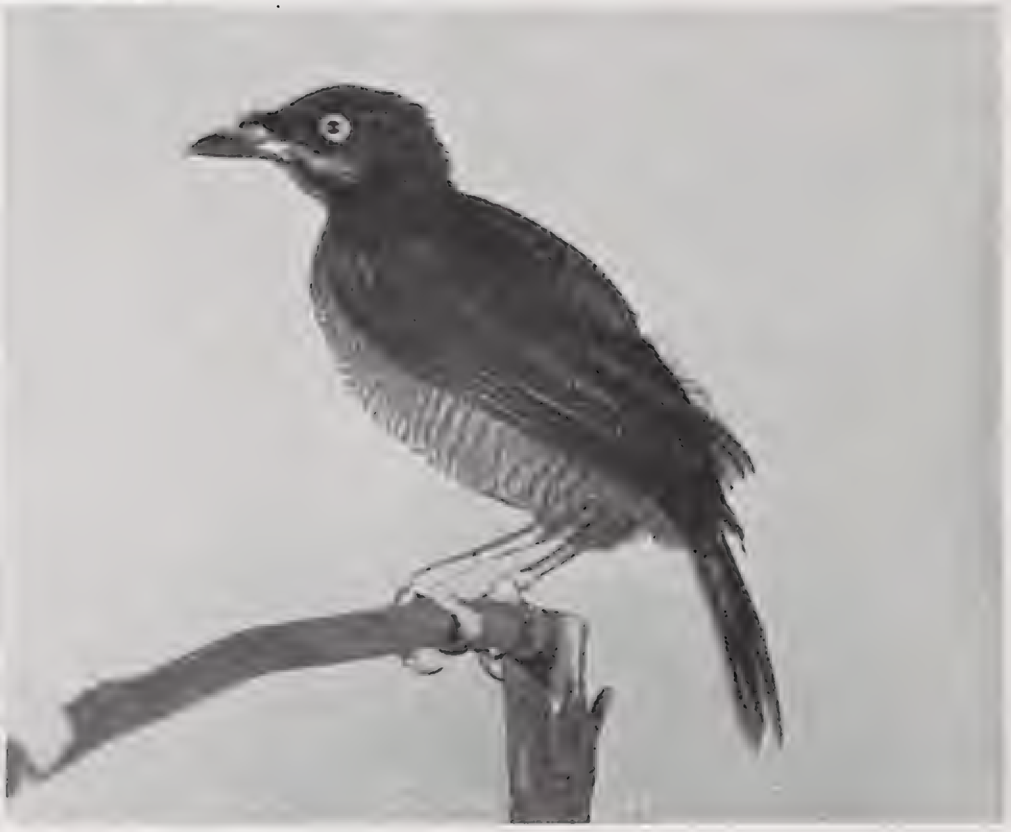
(Upper right) James's Horned Manucode.

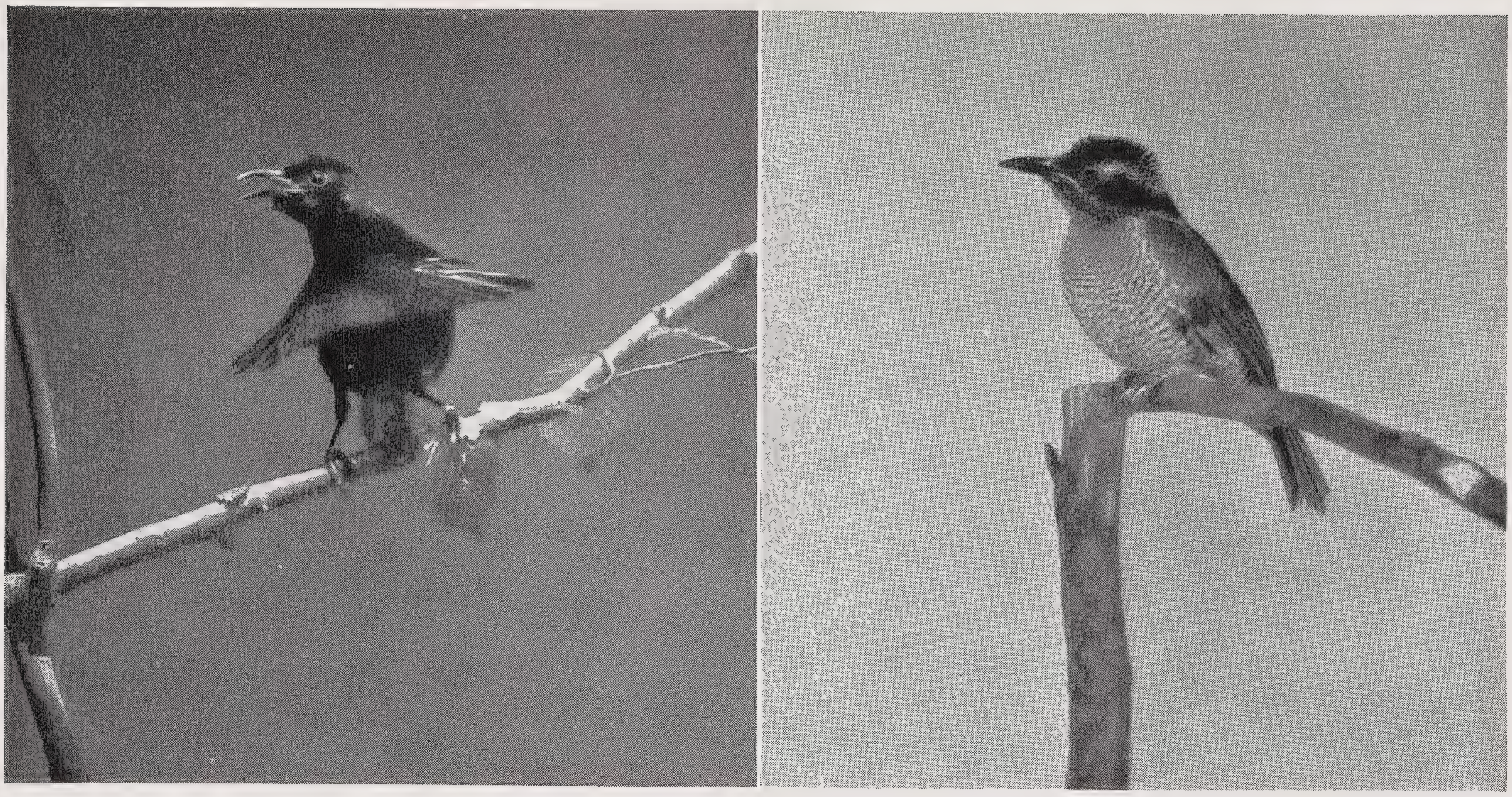
(Left) Greater Six-plumed Bird of Paradise.

(Lower left) Lawes's Six-plumed Bird of Paradise (cock).

(Lower right) Lawes's Six-plumed Bird of Paradise (hen).







Specimens of the Lesser Superb Bird of Paradise were captured by the Society's Expedition in 1929. While among the smaller species, the Lesser Superb is not the least lovely and the male's breast-plate glows with iridescent colors. Above is a pair.

Magnificent. Its most striking feature is the head, which is bare of feathers, the skin colored bright blue and crossed by one longitudinal and two transverse narrow lines of feathers. There is a yellow ruff at the base of the neck; the back and the edges of the wing coverts are crimson; the remainder of the upper plumage is dark brown and the breast is green. The tail wires recurve in a manner similar to those of the Magnificent.

The Standard-winged Bird of Paradise (*Semioptera wallacii*) was discovered by Alfred Russel Wallace and described by Gray in 1859. But it was not until 1926 that living specimens were secured by Walter Goodfellow for the collection of Mr. J. Spedan Lewis. Other shipments followed and in 1930 we were able to purchase a fine male, which is still living. The Standard-wing is a curious rather than a beautiful bird. In general coloration it is a pale earthy-gray, the feathers of the lower surface margined with green. The breast is ornamented with an iridescent green plate, the ends of which are drawn out to extended points. The most interesting feature lies in two long, narrow feathers that rise from each shoulder and end in nearly white tabs. These are erectile at will. Two forms of this bird are usually recognized: *S. w. wallacii,* from Batjan, and *S. w. halmaherae,* from the island for which it is named.

The manucodes are the most plainly colored of the birds of paradise, all being entirely black relieved only by blue, purple or green iridescence. All but one of the forms are assigned to two genera, *Phonygammus* and *Manucodia,* the former having the head ornamented with pointed crests at each side, the latter lacking these decorations. The list of birds of paradise exhibited in the Zoological Park, given above, probably contains all of the manucodes that have been kept in captivity. The range of the group extends from Waigou and neighboring islands throughout New Guinea and to Fergusson Island, where the Curl-crested Manucode (*Eucorax comrii*) is found. This is by far the largest and finest of the manucodes but, like its fellow-islander, the Gray-chested Bird of Paradise, it does not appear to have been collected alive.

The Six-plumed Birds of Paradise (*Parotia*) are named for six long, denuded plumes that rise from the head, each bearing a small racket at its tip. They are found only in the mountains, possibly coming down to as low as 3,000 feet and probably not going much higher than 6,000.

There is some dissension as to the arrangement of the various forms, the chief point being whether they should be considered as one species or four. For the purposes of this article we may follow Hartert[14] and consider the species as four.

The Greater Six-plumed (*P. sefilata*) comes from northwestern New Guinea. The plumage of the male is almost entirely a deep velvety black, with a brilliantly iridescent patch on the breast. A tuft of short, erectile feathers at the base of the beak is blackish with silvery tips. Lawes's Six-plumed (*P. lawesi lawesi*) from southeastern New Guinea is smaller and has the coloration of the nasal feathers reversed: white bases and blackish tips. Another form, *P. l. helenae,* from a little further north, and a subspecies recently described by Greenway[15] as *P. l. fuscior,* do not seem to have appeared in captivity. This applies also to *P. carolae,* of which three forms are admitted, all from northwest New Guinea. This species differs from the others chiefly in having the flanks white. Wahne's Six-plumed (*P. wahnesi*), from northeastern New Guinea, is perhaps the finest of this group, having a very long tail and nasal plumes that are golden instead of silver. This lovely bird has appeared in captivity on only one occasion, a male specimen having been brought to the Zoological Gardens of London in 1931 by F. Shaw Mayer.

The Superb Bird of Paradise (*Lophorina superba*) is one of the smaller but certainly not the least lovely of the group. The male is entirely black in color, with a long cape growing from the nape and extending over the back. The head feathers are highly iridescent and there is a breast-plate of burnished green, drawn out to long points at the sides. There are at least four forms of the Superb: *L. superba superba,* from northwestern New Guinea; *L. s. feminina,* from the north; *L. s. minor* from the southeast; and *L. s. latipennis* from the northeast. There seems to be no record of the first two forms in captivity. The Lesser Superb (*L. s. minor*) has been seen and specimens were secured by the Society's expedition. The Long-plumed Superb (*L. s. latipennis*) was brought to London by F. Shaw Mayer with his 1931 shipment and a male was secured for our collection.

While this article is in no sense a complete résumé of the birds of paradise, it contains brief reference to all the species which have found their way into the collections of private aviculturists or public institutions, with occasional mention of related desirable forms. It is hoped that the descriptions, despite their brevity, may still suggest something of the elusive beauty of these birds that lies outside the realm of words.

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[14] Hartert, Ernst. *Novitates Zoologicae,* Vol. XXXVI, 1930, p. 31.

[15] Greenway, James C., Jr., *Proc. New Eng. Zool. Club.* Vol. XIV, 1934, p. 2.

Snakes and Surprises

A Water Cobra from West Africa Is the Latest Unexpected Rarity to Reach the Reptile House

RAYMOND L. DITMARS

SOME of the most unusual specimens exhibited at the Zoological Park arrived as unexpectedly as if they had dropped from the sky. Two exceptional members of the reptile collection, apparently the first of the species ever to come to a zoological institution, suddenly appeared in this way. One was the African aquatic cobra, a recent accession that is now on exhibition.

On a day in August in the present year, Mr. Warren Buck of Camden, N. J., visited my office to explain that he was leaving for Portuguese East Africa and would try to collect an interesting series of reptiles for us. He added that he still had a large cobra left over from a former collection and he asked me to take it.

I was not particularly interested in acquiring any more cobras, since we had a fine series of them with both Indian and African species represented. In fact, we already had several forms from Africa. But Mr. Buck insisted that his specimen was unusually fine. He remarked that he had picked it up on a trip to the west coast of Africa. That failed to catch my interest, too; I already had four cobras from western Africa.

We chatted a few minutes and he started to take his leave. Apparently he was still upset about having to leave his west African cobra behind in Camden while he was away, for he remarked that it was too bad I didn't want it and that he wouldn't have time before his departure to get in touch with the other zoological gardens in this country that might be interested. He left my office, saying with a smile that he would stop on the way out through the Reptile House and look at our cobras and at least console himself with the thought that he had a finer one than we did.

In less than five minutes he was back in my office. "I tell you, not one of your cobras compares with mine," he said. "My west African cobra has rings around his neck, and he's greenish in color."

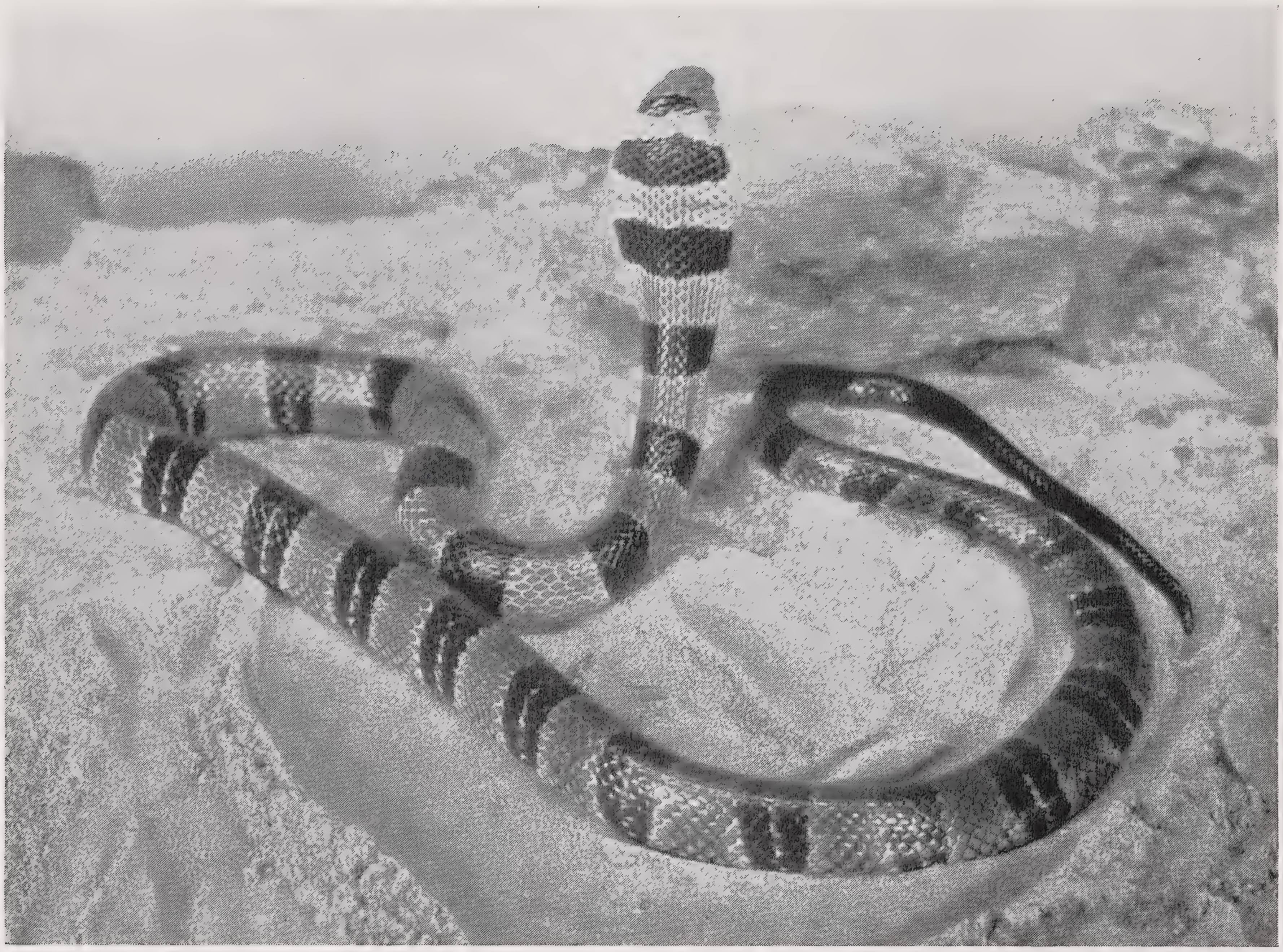
"Well, that sounds like the anteriorly banded form of *Naja nigricollis*," I replied. "That snake ranges through various colors and the pale-hued forms show black neck-bands."

"But my cobra has rings all the way down to his tail."

Right there I began to get interested. This was something I didn't know about, from a country where a dozen or so species of cobras range through a great variety of colors and patterns. It seemed worth looking into, and so I bought the snake. Even when the shipping case arrived a few days later I opened it in full expectation of seeing an unusual variation of *Naja nigricollis*. Headkeeper Toomey and I were wearing goggles as we opened the case, as *nigricollis* in all its forms is notorious for ejecting its venom for a distance of ten to twelve feet and aiming at one's eyes.

The snake that reared up out of that case was utterly unlike any of its clan I had ever seen alive. I cast back through memory, and I seemed to recall some jars of rare African material assembled at one time for a special exhibit at the American Museum of Natural History. One had contained a preserved specimen of the water cobra, *Boulengerina annulata*, the only known species of aquatic cobra. I remembered looking upon that big jar with considerable interest and pondering what must be the habits of that strong, sleek serpent with its indications of a dilatable neck and a head type suggesting alertness and activity.

The more I looked into the literature and background of the new cobra that had come to us so casually the more interested I became.



The new water cobra was almost a perfect subject for the photographer. He reared on the slightest provocation and held his expanded hood quite motionless for a minute at a time, displaying his strong markings.

At the time I saw the preserved specimen, all that was known about the species was its habitat—the rivers of the Cameroons and the Congo. As late as 1930 Arthur Loveridge of the Museum of Comparative Zoology at Cambridge, Massachusetts, who had traveled widely in Africa in the course of his herpetological studies, wrote that nothing seemed to be known about the habits of the water cobra found in Lake Tanganyika.

But in 1931 on his return from investigations in the southwestern highlands of Tanganyika Territory, Mr. Loveridge published some interesting notes about the water cobra in the *Bulletin* of the Antivenin Institute of America. He assigned the snake to the genus *Boulengerina,* and clarified the scientific status of the species by stating that the aquatic cobra of Lake Tanganyika, hitherto known as *Boulengerina stormsi* Dollo, shows on the basis of material newly collected to be a race of *Boulengerina annulata* (Buchholtz and Peters) of the Cameroons and Congo. This snake (preserved) is represented in few collections, not because it is rare in Tanganyika but presumably on account of the difficulty of securing specimens of a snake of its peculiar habits.

In the following paragraphs Mr. Loveridge described its habits for the first time in detail:

> Kasanga is situated on delta flats in the centre of a sandy bay whose arms are formed by rocky promontories projecting into Lake Tanganyika. On one of these the Germans built their important military base of Bismarckburg. Both promontories are protected by natural breakwaters of piled-up masses of rock; it is just off such rocks that the aquatic cobras are to be found.
>
> According to native reports, which my own experience confirmed in some points and contradicted in none, when the sun rises and strikes the rocks the cobras emerge from their retreats beneath them and bask for a short time *on the tops* of the rocks. Shortly afterward,—and I found none on the rocks an hour and a half after sun-up—they take to the water in search of fish. I was told that on a calm day one might see as many as ten in the course of a morning's fishing. We saw four in a little over three hours. The rocks slope precipitously beneath the water so that it is often ten feet deep within ten feet of the shore. I hired a boat and cruised very quietly along shore peering through the clear waters at

the jumbled boulders, in and out among which brilliantly coloured small fish in great variety, darted or hovered. At last we saw a great head come out from beneath a rock followed by the handsomely barred neck and body of a large cobra which I estimated as about eight feet in length. Native reports allege that they reach a length of ten feet which I do not think improbable.

The natives were greatly excited and urged me to shoot it, so I fired first one and then the second barrel at the snake which was between three and four feet below the surface; as I should have known, the bullets were deflected and did not penetrate the water, and the only effect upon the snake was to cause it to retreat beneath the boulder. As I was waiting for its reappearance, a cry was raised from a watcher aft that a second snake was close by. Glancing in the direction indicated, I saw a young three-foot cobra dart through the water with all the agility of an eel and disappear into a crevice among the submerged rocks. I concentrated on the first snake seen, however, and presently its head and a couple of feet of its body appeared. With my snake stick I pinned it down against a submerged rock, but the rock was slippery and with a few powerful convulsive jerks the reptile threw off the stick. Later the incident was repeated with another large cobra and I was forced to the conclusion that I was merely making myself ridiculous in attempting to hold down such powerful reptiles in their chosen element with nothing but a T-ended stick.

Mr. Loveridge told more of his efforts to capture the snake alive, and declared that he finally found it necessary to shoot his specimens. His notes concluded:

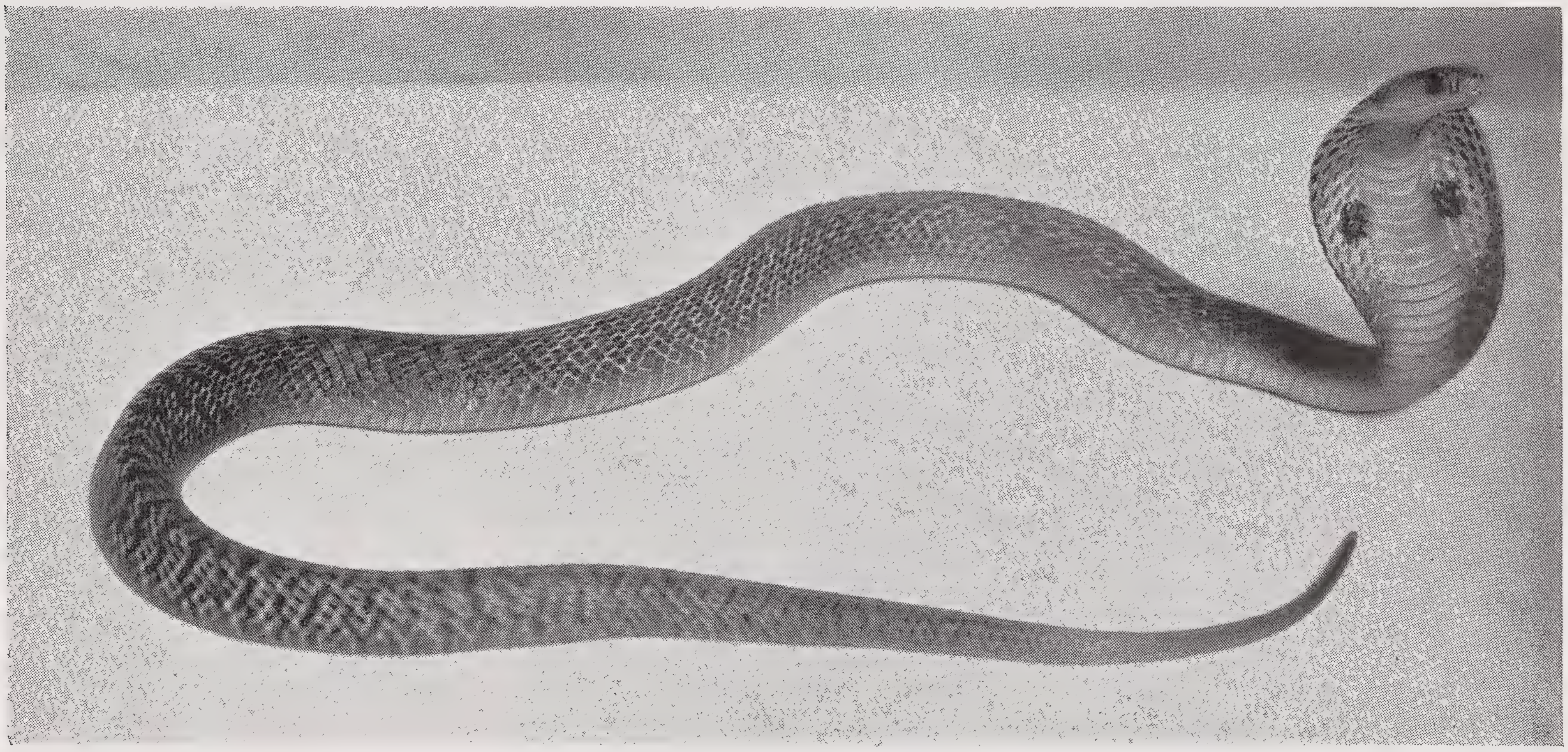
According to the local fishermen, these cobras are rarely seen out in the lake and are only to be encountered in the vicinity of rocks; the same opinion was prevalent in each of the localities visited. It seems probable that at times they do so venture, otherwise they could scarcely have obtained their present wide distribution in the lake.

I came to the conclusion that, out of their element, they are not aggressive nor to be feared as much as the true cobras. Possibly their sight is not so good on land as under water; it would appear likely that it has undergone modifications to enable them to see clearly the fish on which they subsist.

I found it interesting to check the action of the water cobra in the Reptile House against Mr. Loveridge's observations.

The snake is slightly more than five feet long. When it arrived it was having difficulty in shedding its skin, particularly in casting the plates over the eyes—a common trouble with captive cobras—and so it was transferred to a large sheet-iron can with a locking, ventilated top. After soaking in the six inches of water in the bottom of the can and rubbing against the rough stone provided there, the snake shed all of its skin except the caps over its eyes. Later it went through another shedding and the eyecaps, now doubled, were successfully cast.

The serpent is an extremely handsome creature after shedding, being pale, olive-green with



A comparison of the expanded hood and the characteristic defensive position of the water cobra with this pose of the spectacled cobra makes it quite apparent that Boulengerina annulata *is truly a cobra, despite its habit of feeding in the water.*

vivid black bands encircling the body. Its appearance is strikingly similar to that of some of the boldly marked species of marine serpents, indicating a curious parallelism. Its tail is vertically compressed and its scales are more polished and lustrous than those of typical cobras.

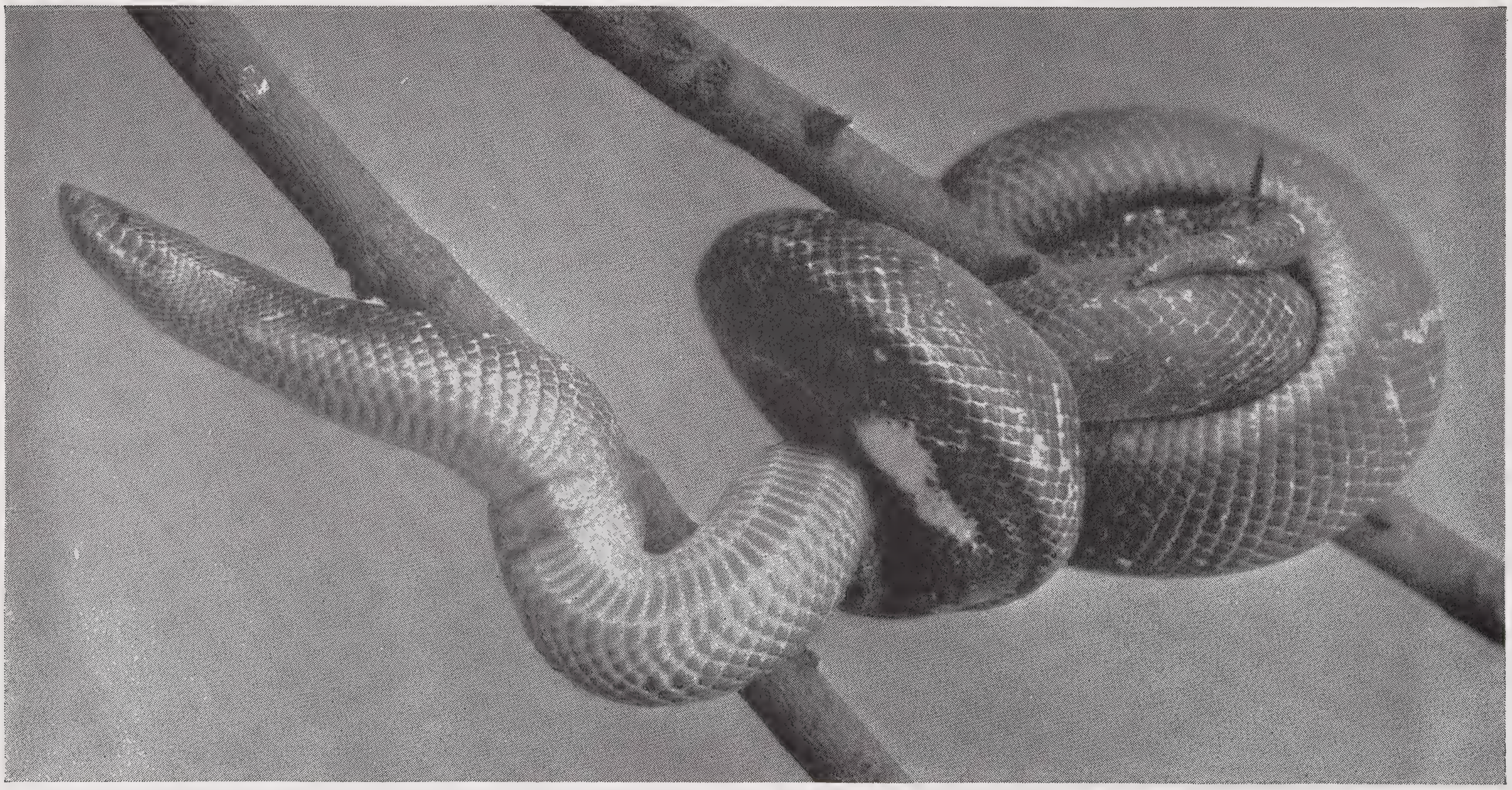
What impressed me particularly about the snake was its calm, fearless manner and its lack of irritability. This is a marked variation from average cobra traits. Members of the genus *Naja* fly into a nervous rage at the least interference and retain their hostile airs through years of captivity. *Boulengerina* will rear in true cobra fashion when touched with the snake staff and will turn this way and that if the observer shifts his position, but its attitude is one of dignified defence and caution and it seldom strikes, nor does it hiss like most land cobras.

The snake's expanded hood is proportionately narrower, though considerably longer, than that of most cobras. It has shown no disposition to eject its venom in a spray of fine drops, which really devilish habit is constant with at least two of the African cobras and may at any time be anticipated from several others.

When we recorded the new specimen photographically we were pleased to find that it readily adopted several arresting poses on the studio table and gave no trouble whatsoever. Moreover it remained quite motionless in some of its reared positions and thereby enabled the photographer to make time exposures. We would have had a lively time of it in the studio with the average big specimen of *Naja.*

Immediately upon arrival we provided the snake's cage with a trough and plenty of water, but it shows no disposition to enter the water. To date it has fed upon very young rabbits but refuses frogs.

Summarizing our observations on *Boulengerina* up to the time of writing this article, it would seem that the water cobra is a much quieter snake than the strictly terrestrial cobras, although relatively stouter and stronger. That it is not altogether dependent upon an aquatic life for its well-being and its food is a circumstance at variance with the facts about most water snakes. Its liking for warm-blooded prey is to be noted here. Its defensive pose and expanded hood stamp it as truly a cobra as the species of *Naja* and the keeled-scaled *Sipedon* of southern Africa. The location of its genus in the systematic lists, the indication of relation-



The Mexican dwarf python, the only true python found in the New World, caused a minor flurry in the Reptile House when the first living specimen arrived several years ago. The excitement faded quickly when a dealer discovered many more of them.

ship, is too remote from the cobra genera as a result of the previously scanty material—all of it in museum jars. The actions of the snake have been something of a revelation and may help in pointing to an interesting phase of relationship.

Several years ago another snake extremely rare in collections arrived at the Zoological Park. It was a specimen of the Mexican dwarf python, *Loxocemus bicolor,* the only true python known to exist in the New World. It had been my understanding that less than a dozen specimens had ever reached the collections of the museums of the world and that there were but three among all the museums in the United States—all dead, of course. I had never seen a living example but I had instructed Mr. W. A. King of Brownsville, Texas, who does considerable collecting in Mexico, to watch for the snake. He had carried my instructions in mind for about ten years without results.

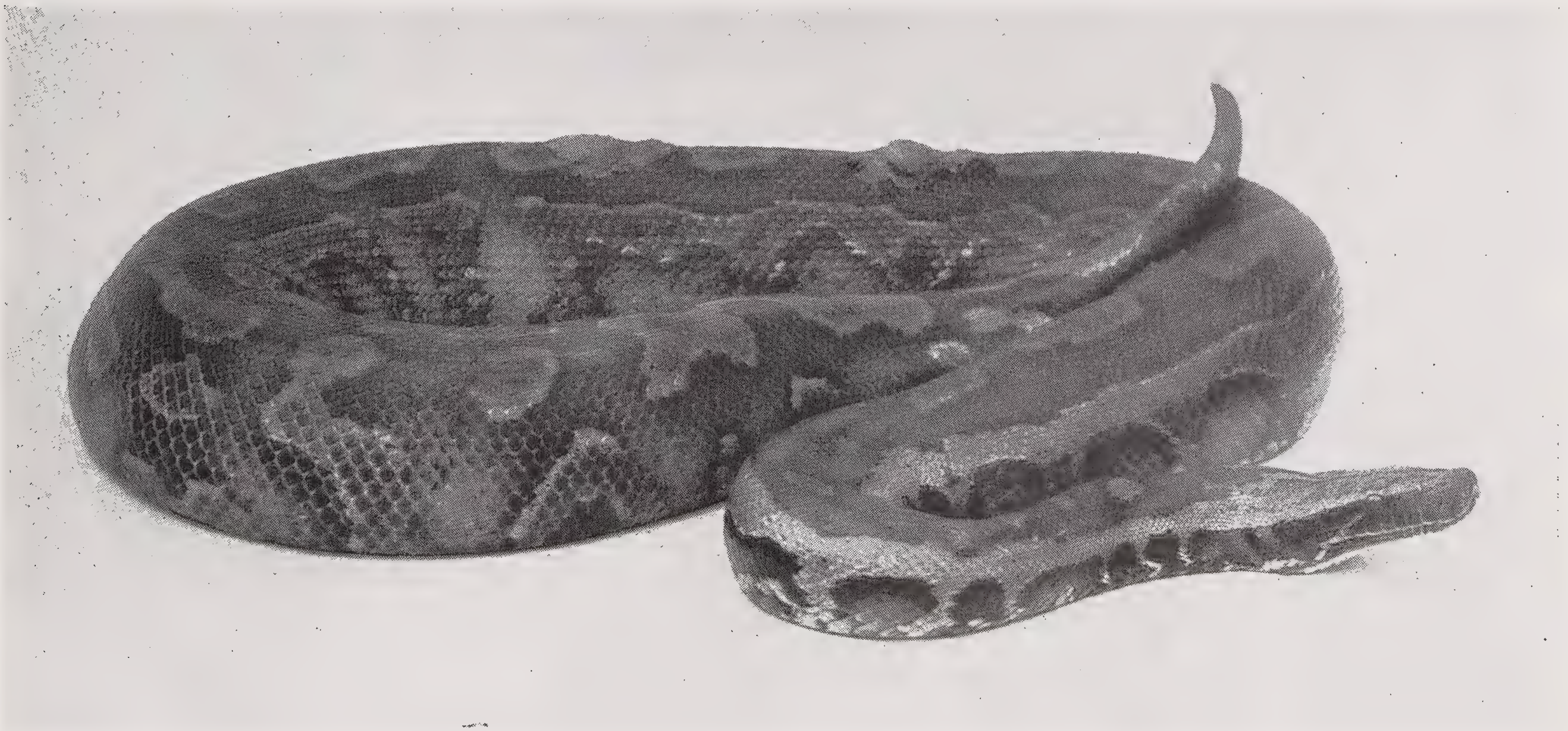
Then, one day, opening a small box that arrived by express, I was thrilled to see a living specimen of the dwarf python. It was about two and a half feet long, a lustrous deep brown glowing with purple iridescence, with creamy spots along the body.

At once I dispatched a letter of congratulation to Mr. King and to my astonishment his response was in the form of another specimen and a note from the collector that he was sending still others to other zoological institutions. He had, apparently, found a ready source of supply, at last.

A parallel incident involving another snake occurred not long after. I was visiting the National Zoological Park in Washington, D. C., and was much interested when Dr. Mann, the director, showed me a specimen of the blood python, *Python curtus,* a curious constrictor about four feet long but excessively stout and reddish in color. We decided that this was the first example of this rare snake to arrive alive in the United States.

A year later Mr. Ross Freeman, an American in charge of extensive rubber planting in Sumatra, came to the United States on a holiday. Just before he left his coolies had been cutting deeply into the jungle to clear ground for young rubber trees and Mr. Freeman had collected quite a series of reptiles for us. As I looked among the boxes arranged in the Reptile House receiving room he lifted the lid of a particularly large box—and displayed *fourteen* blood pythons!

"Why, that's the commonest snake on the plantation," he said when I exclaimed over the rarity of the snake in American collections. "Once we cleared the jungle, they trooped in there from all sides!"



The blood python was a real rarity for a little while—until a rubber planter showed up with fourteen in one box! He said it was "the commonest snake on the plantation."

The Wild Duck Situation

What Effect Will the New Hunting Regulations and Restoration Projects Have on Our Migratory Waterfowl?

William Bridges

At the opening of the hunting season this fall the wild ducks of North America find themselves in the most favorable position they have enjoyed in years. The difference is not great: it is, merely, that extinction of one species after another has become less certain. For even so tiny a ray of hope, the game species of waterfowl can thank the most stringent hunting regulations ever imposed in this country and the commencement on a larger scale of the restoration of breeding grounds and the creation of sanctuaries.

True conservationists and sportsmen have always disagreed about the seriousness of the wild duck situation and their disagreement gave rise to two opposing theories as to what ought to be done.

Said the sportsman: The only cause of the duck crisis is the encroachment of agriculture on breeding and feeding grounds, plus recent drought years that have damaged many of the good breeding grounds that were left. Shooting has virtually nothing to do with the situation.

The duck hunters' attitude is pretty well summed up in a pamphlet on "The Duck Decline in the Northwest" issued by More Game Birds in America, Inc.:

> This is no time to experiment with substitutes or to squabble about petty, unpopular and unenforceable shooting restrictions presumed to provide the remedy. The question rather is to attack the problem forcefully at its weakest link, to tackle it where the result will be most fruitful: On the breeding grounds. An increase in the supply by aiding the birds to multiply should have first consideration.

Said the conservationist: Overshooting is the primary cause of the declining numbers of wild ducks. There are not enough left to populate even the good breeding grounds. Limit shooting severely or stop it altogether for one season or more until the ducks have a chance to come back. By all means try to reclaim breeding grounds from unprofitable agriculture and establish food-stocked sanctuaries, but don't forget that all the duck marshes in the world won't bring wild ducks back if you have shot down all the breeding stock.

Those two positions have contended for supremacy for years, and the number of wild ducks has gone right on declining. Neither one theory nor the other captured the undivided attention of the Federal authorities in a position to give it effect—in recent years the Biological Survey. Bag limits went up and down, the length of the hunting season expanded and contracted, experiments with baiting permits, rest days, sanctuaries on gun club grounds, and so on, were all tried and still ducks did not make the predicted comeback.

At the close of the last hunting season the signs of a crisis began to appear convincing even to the most intransigeant duck hunter. Conservationists demanded a closed season to preserve a minimum breeding stock and freely predicted that one more virtually unlimited hunting season would mean the end. Even a few sportsmen's organizations joined the plea for a cessation of the human war on ducks, but the majority remained silent or undertook to minimize the seriousness of the situation.

Mr. John H. Baker, the executive director of the National Association of Audubon Societies, stated the reasonable attitude of conservationists when he said in an appeal for a closed season directed at the Secretary of Agriculture:

> Were duck hunters to back a one-year moratorium now, conservationists would be favorably impressed. Were the conservationists not to oppose a reopening of the season when an adequate breeding stock of the birds has been restored, duck hunters would be favorably impressed. Here then is an opportunity to further better under-

National Association of Audubon Societies

Wild ducks coming down to feed, not in baited waters in front of a hunter's blind but in a sanctuary where food and protection from the guns are assured them. Eventually a chain of sanctuaries will extend along all the four great flyways.

standing and promote greater future coordination of conservation effort.

Mr. J. N. Darling, the chief of the Biological Survey, on whom rested responsibility for hunting regulations, let it be known that he intended to make his decision on a basis of facts and would not be forced into any position by demands either for or against a closed season. His investigators were sent out on a survey of the breeding grounds.

In advance of their final report Mr. Darling suggested in the May-June number of *Bird Lore* that 18,000,000 to 20,000,000 wild ducks remained alive to perpetuate some two dozen species. Subsequently his investigators drifted in with reports of a more successful breeding season than had been anticipated and their findings apparently influenced him to a decision to permit an open season, although drastically restricted. When he promulgated the hunting regulations on August 1 he made a revised estimate of 24,000,000 birds. Early in September More Game Birds in America, an organization representative of the sportsmen's philosophy, completed an independent survey and gave out a considerably more optimistic forecast of 40,000,000 ducks.

Mr. Darling further estimated, according to the Associated Press on August 2, that "24,000,000 ducks will fly south this fall and 12,000,000 will be killed by hunting or natural causes. He figured 9,000,000 were killed by hunters last year, and the kill this year would be from 5,000,000 to 6,000,000." More Game Birds in America made no estimate of the probable kill under the new hunting regulations that limit

U. S. Bureau of Biological Survey

Waterfowl resting and feeding places such as this one in Alberta, Canada, must be restored over large areas if wild ducks are to have a successful chance at survival.

the open season to thirty days, eliminate sinkboxes, sneak boats and open-water shooting, prohibit shooting over baited water or land, prohibit the use of live decoys, substitute north and south zones for the previous plan of zoning by States, restrict shooting to the hours between 7 A.M. and 4 P.M., reduce certain bag limits and make illegal possession of more than one day's bag limit. Most sportsmen, however, look for a greatly reduced kill this year because of the restrictions.

So the conservationists have gained something, if not all, of what they hoped for. Shooting has at least been restricted until the ducks begin to have a sporting chance. As a Biological Survey report put it, "As a result of the elimination of the artificiality of 'duck shooting' [by means of restrictions in this year's hunting regulations] it is hoped that sportsmen will get back to the basic principles of 'duck hunting' to their own advantage and that of the birds.' "

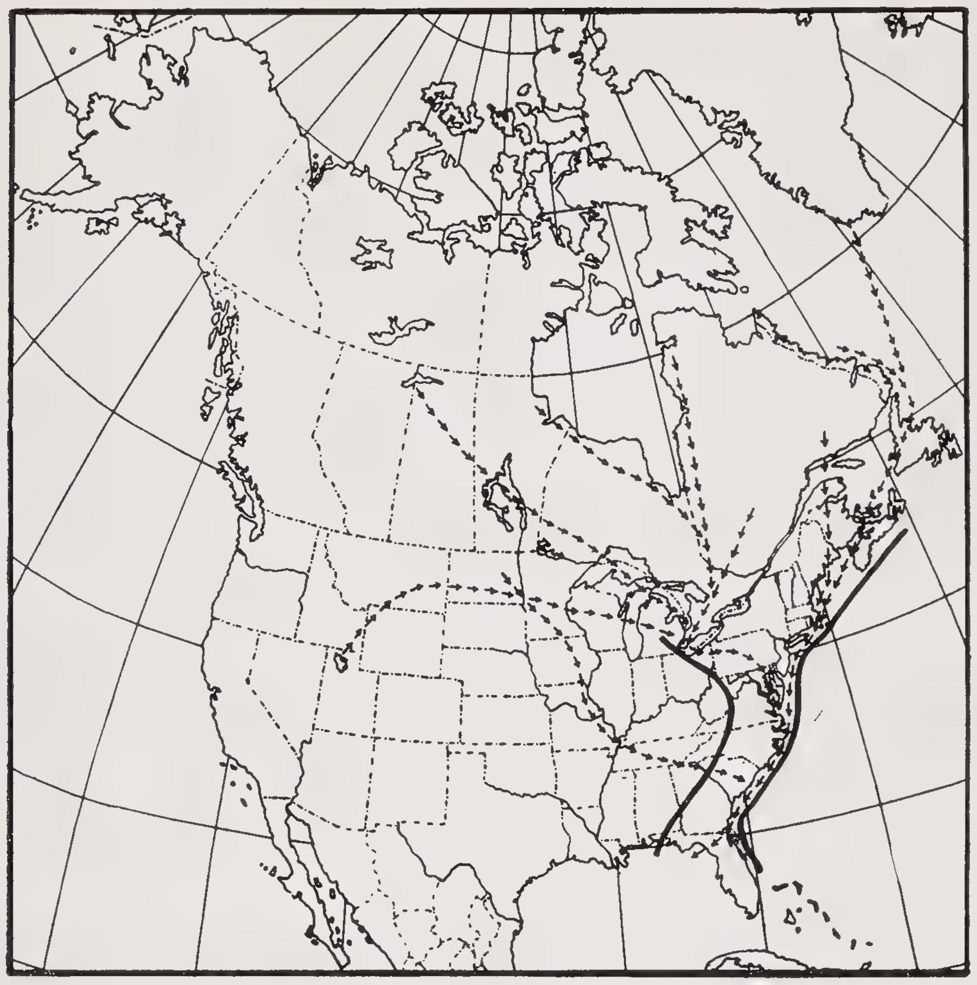
National Association of Audubon Societies

Under the new hunting regulations this fall, live decoys are prohibited and hunters will be forced to use wooden decoys such as those pictured here.

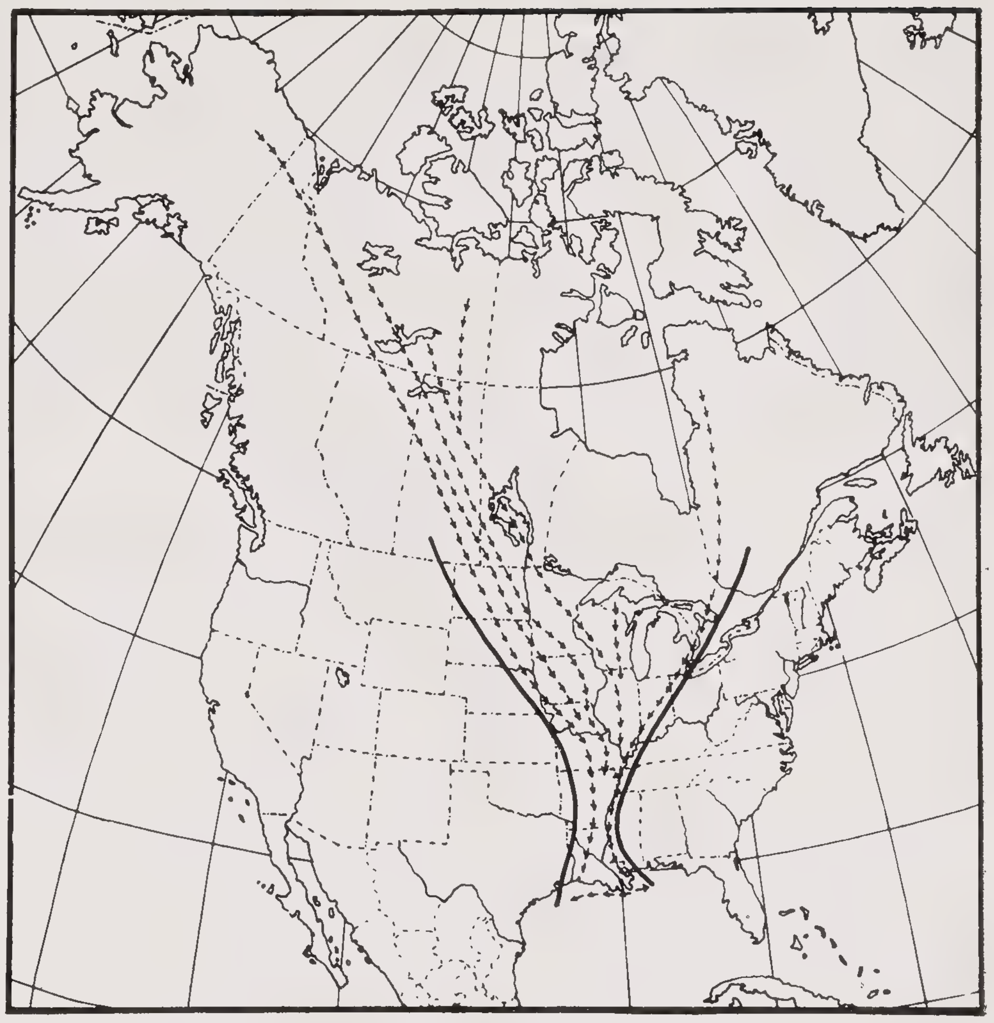
This year for the first time it will take more than the ability to hold up a gun and pull the trigger to bring down a duck, more than the possession of enough cash to buy the privilege of shooting over live decoys and baited waters in a duck club. The man who brings in a bag this fall will be a duck hunter and not merely a duck shooter, and the advantage is immensely on the side of the ducks.

The restricted hunting regulations give the friends of the wild waterfowl more hope that there will be a breeding stock left to return to the northlands next spring. Now, what are conditions in the vast breeding areas of the northwest and what may be expected of the restoration projects?

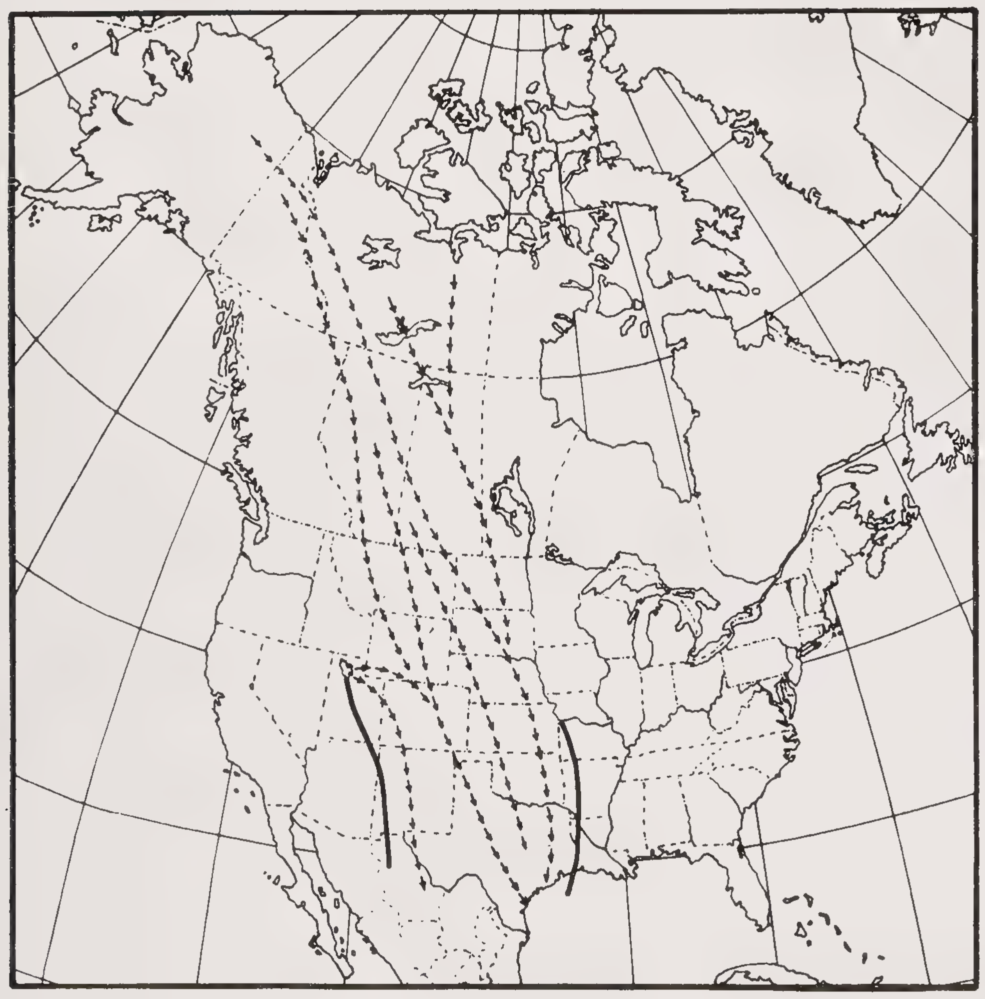
Conditions on the breeding grounds are still very bad, even though they have been worse. The Biological Survey and More Game Birds



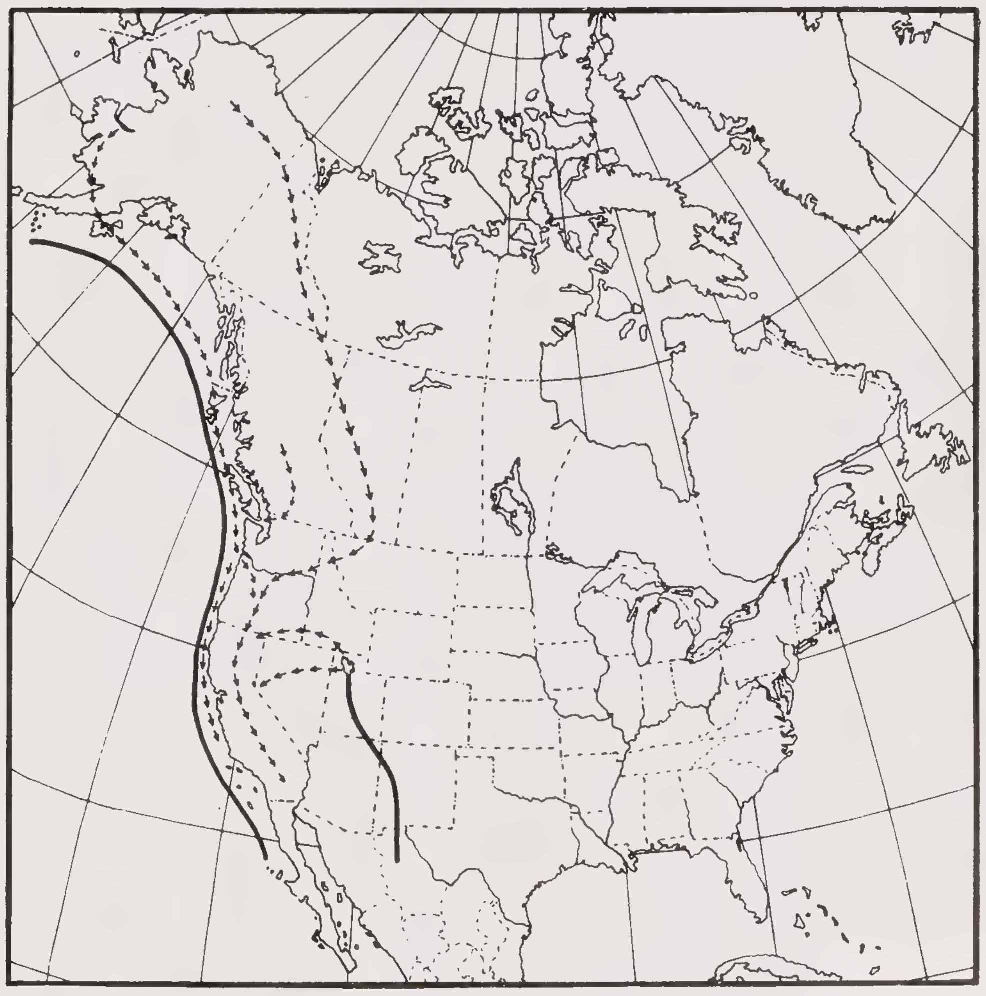
Atlantic Waterfowl Flyway



Mississippi Waterfowl Flyway



Central Waterfowl Flyway



U. S. Bureau of Biological Survey

Pacific Waterfowl Flyway

in America, the two sponsors of population surveys, show a disparity of 16,000,000 birds in their figures and conservationists will be inclined to put more faith in the report of the government agency as the more conservative—and more disinterested—of the two. On August 25 the Biological Survey said:

Our migratory waterfowl are coming back. The improvement in the general situation is not great, as indeed it cannot be in one season after so many years of steady decrease, but considering the continent as a whole there *is* an improvement, which must cheer those who are laboring so diligently for this objective.

The most heartening news is from the breeding grounds of the United States. The northern parts of the range that are north of the Canadian agricultural belt are, of course, as unaffected by drought and the works of man as they were one hundred years ago, although they are still supporting only a pitiful remnant of the birds that formerly used them.

Such efforts at restoration of breeding grounds as the Biological Survey was able to make with extremely inadequate funds at its disposal have been concentrated largely in the northwestern area of the United States and it is there that the conditions are reported most favorable this year, giving hope that an extension of the restoration project, in conjunction with restricted shooting, will bear fruit. Nearly 1,000,000 acres have been acquired or put under contract by the Biological Survey to date for wild life purposes and another 2,000,000 acres are to be added by 1940 if funds hold out. Distributed along the four great flyways that cross the United States from north to south will eventually be chains of sanctuaries where the migrating waterfowl may rest and feed under Federal or State protection. The last Congress made available $6,000,000 to the Biological Survey for wild life purposes—a sum that for the first time gives it the motive power to go ahead.

Admittedly the restoration of drought-stricken, drained, ploughed, grazed and cultivated sub-marginal lands that once were the breeding grounds of ducks is a slow and expensive process. Only about 15 per cent. to 20 per cent. of the ducks breed in the United States and the most complete job of restoration in this country will not adequately affect the total supply. But a start is being made after years of talk, and if the hunters can be forced to leave a breeding stock to repopulate the restored areas, the case of the wild duck may not be altogether hopeless. It will be the task of true conservationists for some years yet to come to make sure by their vigilance and influence that the merest flicker of returning strength is not extinguished in a renewed roar of the guns.

Horseshoe Crabs with Forked Tails

E. W. Gudger

Bibliographer and Associate Curator of Ichthyology,
American Museum of Natural History

THE horseshoe or king crab, in scientific parlance commonly called *Limulus polyphemus,* has an ancient and honorable lineage. It is a member of the order of F. F. A. (First Families of Animals) of the world. One can trace its history from its closely related forms in the Oligocene Period back through the Cretaceous, the Jurassic and Triassic Periods, and through what seem plainly ancestral forms in the Carboniferous, Devonian, and Silurian Ages, far back to the trilobites of the Cambrian Age. Furthermore, in its life history *Limulus* goes through a distinct trilobite stage and this is added evidence of its ancient ancestry. Horseshoe crabs, of which there are three genera and four or five species living, are today confined almost entirely to the northern hemisphere—to the western Atlantic (from Maine to the West Indies and Yucatan); to the western Pacific (from Japan to the East Indies); and to the northern Indian Ocean (from the Bay of Bengal into the East Indies). And one species is found throughout the whole East Indies—from Singapore to Torres Straits.

Although the horseshoe crab is absent from European waters, its fossil forms and fossil relatives are found in the Cretaceous, Jurassic and Triassic rocks of that continent. One form of the living animal is found in North American waters. As fossils, related but less specialized Limulus-like forms are found in our Carboniferous, Devonian, and Silurian rocks, but so far as I can ascertain no fossilized horseshoe crabs have yet been found in North America.

This wide but discontinuous distribution of both living and fossil forms of the horseshoe crab tribe leads to the plausible suggestion that formerly there was a continuous coast-line with tropical or at least temperate conditions, extending from Europe westward to North America and eastward into Asia.

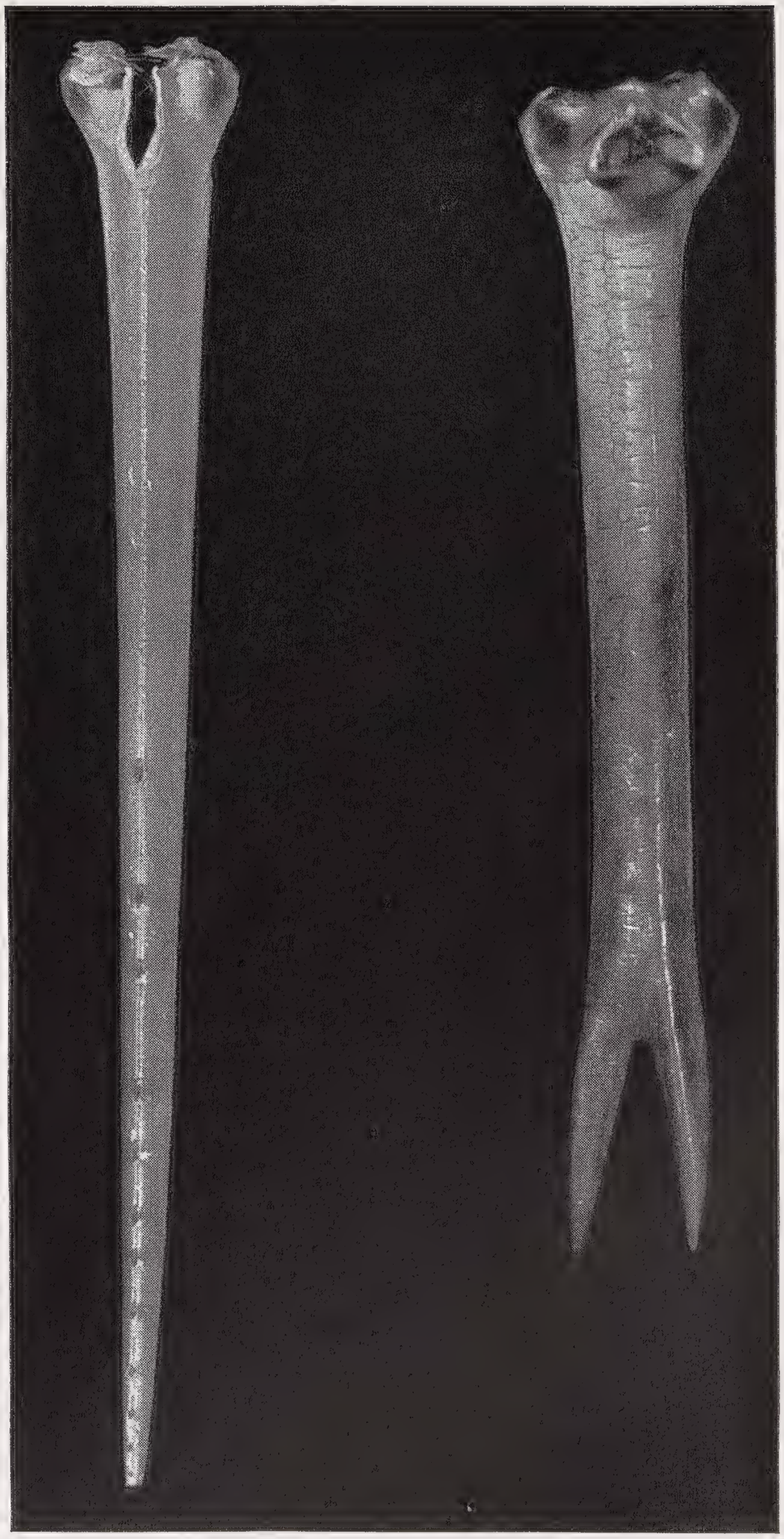
The names of our animal are interesting.

Horseshoe crab is a good name, since the carapace or chitinous covering of the anterior part of the body is shaped like the hoof or shoe of a horse. But why king crab? In the same way the generic appellation, *Limulus,* is also a complete misnomer, since it is a diminutive of the Latin *limus,* meaning sidelong or askance. The name first given to this animal is *Xiphosurus,* from the Greek *xipho,* sword, and *oura,* tail, in allusion to the slender, pointed, caudal spine, and it should be so designated today. *Polyphemus,* as we all know, was the giant whose cyclops or median eye was put out by Odysseus and his companions by the use of the heated point of a long pole. It is a very good name here because our animal has at the middle of the front edge of the carapace a slight elevation on either side of which is a small simple eye—these in addition to the large compound eyes further back and laterally placed. These paired simple eyes appear as one at first glance.

Xiphosurus, the sword-tail, has a long, straight, tail spine, extending back from the abdomen as one may see in the picture of the normal animal. This spine is three-angled, as the photograph of a normal tail spine shows, and is flat on the dorsal surface with the apex of the triangle on the ventral side. Furthermore, this ventral surface is provided with short, sharp, backwardly projecting spines along the hinder edge. Such is the normal caudal spine, but let us now turn to the forked specimens.

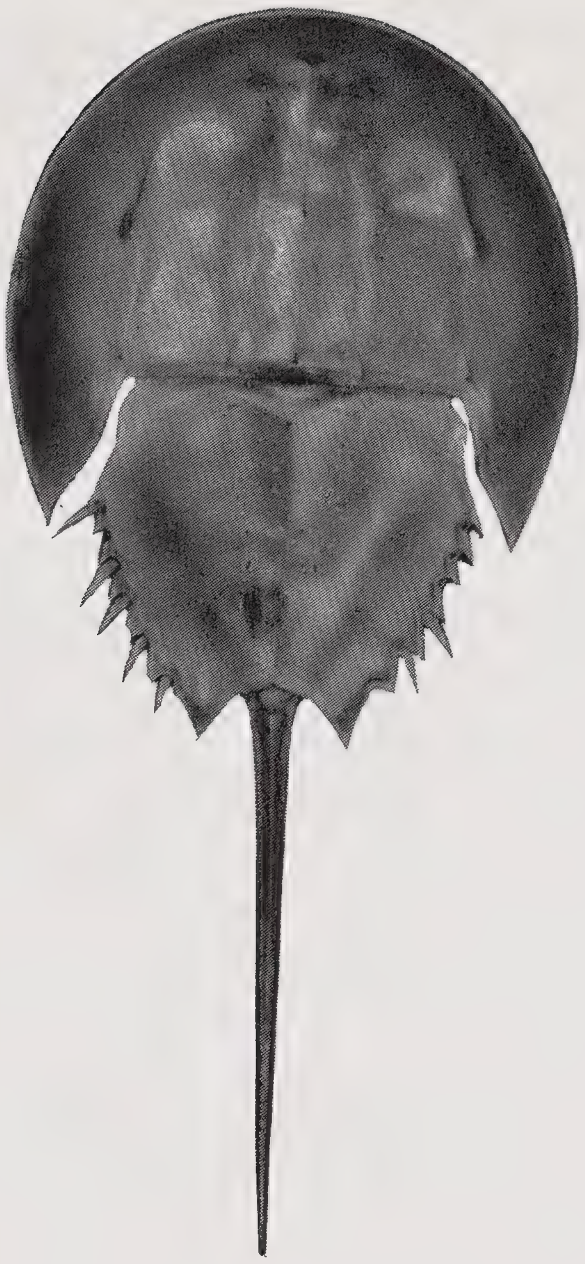
On a recent visit to Sanibel Island, off the west coast of Florida, I was shown the forked tail spine figured (in ventral view) alongside the normal tail spine. This was found by George Underhill, an experienced fisherman and guide, and was cut from the live animal caught in his net. This forked tail is 3⅞ inches long. To the eye the prongs look unequal in length, but the difference is slight (1/25th of an inch).

Looked at from below, the (animal's) left-hand spine appears to continue the main stem of the tail, since the ventral ridge extends out on it and the right one seems divergent. It is notable that there are no spinelets or prickles on this tail. Seen from above, the whole tail is twisted slightly to the left, with the left point below the level of the right one. The bifurcation is, however, practically symmetrical, the left fork measuring 18 millimeters and the right 19 millimeters.

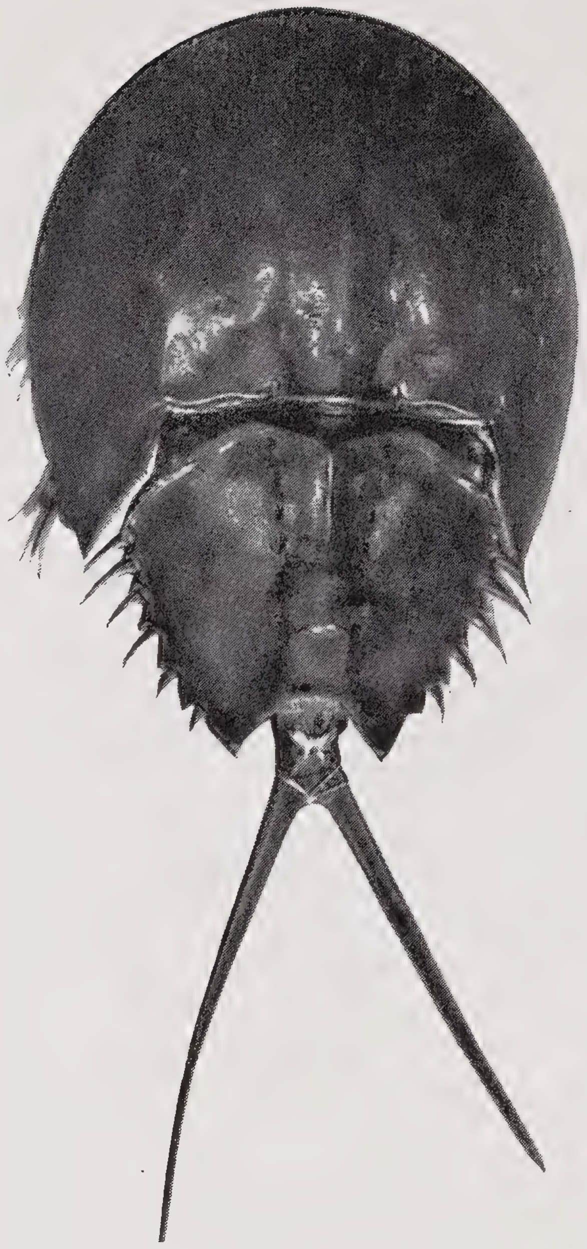


On the left is the normal tail spine of a horseshoe crab, and on the right a forked spine from Sanibel Island, Fla.

Horseshoe crabs abound by tens if not hundreds of thousands at Sanibel and in adjacent waters, and information was sought among the fishermen there as to the prevalence of forked tails among these animals. George Underhill had never seen another example. Joe Williams thinks that he has seen five or six in thirty years' fishing. Sam Woodring has seen three or four in some fifty years' experience, but Mrs. Woodring declares that in the past few years she has found two forked tails, one sym-



A normal horseshoe crab is pictured on the left and "the most unusual forked tail ever described" on the right, from a specimen found in 1911. Below is the forked tail illustrated in Packard's monograph.

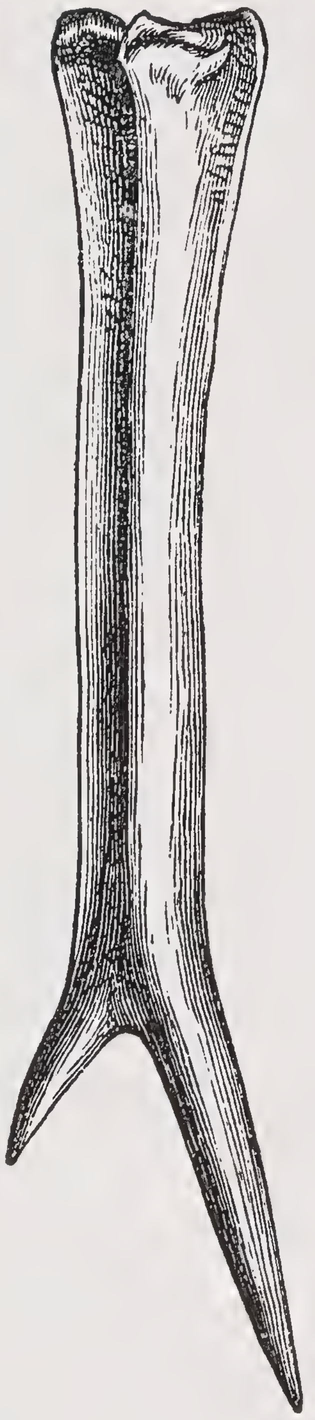


metrical like the one described above, the other having the fork in the shape of an offset like that next to be figured and described.

From all this, it must be concluded that while this deformity does occur in the horseshoe crabs at Sanibel (and elsewhere), its occurrence must be rare. However, it can be pretty confidently said that if any such specimens are found at Sanibel in the near future they will surely reach my hands.

In searching the literature for accounts of forked tails of the horseshoe crabs, I have found but two. The oldest of these is an incidental paragraph in the monograph of A. S. Packard, Jr., on the development of the horseshoe crab (*Memoirs Boston Society of Natural History*, 1872, vol. II, p. 201, fig. 36). Of it he writes that this specimen (six inches long) was collected on Fort Macon Beach, Beaufort, N. C., at a date not indicated. He never saw another and hence was "inclined to believe that this deformity is very rare." Incidentally I may remark that it was on this beach in 1902 that I saw my first horseshoe crab, but never then nor later one with a forked tail.

Packard's illustration is reproduced here. In it the tail is seen from below. The left prong seems to represent the main stem of the caudal spine bent to one side, the smaller fork being a decided offshoot. This tail also lacks the small prickles on the ventral surface. It was such an unsymmetrical fork as this that Mrs. Woodring found on one of her specimens.



And now I come to the most unusual forked tail ever seen and described on a horseshoe crab. Here the two forks arise from the basal part of the tail and diverge widely. The left fork seems more nearly in line with the axis of the body, but the right prong is the more massive. The left tail seemingly has a transverse joint, and the right tail two joints, just beyond the point of divergence. The specimen has disappeared in the long years since it was described (1911) and it is impossible to check up on this matter. Compare it with the normal tail. If these are joints, they are even more unusual structures than the two tails.

This specimen was figured and briefly referred to by Prof. R. C. Osburn in the Bulletin in 1911 (No. 48, p. 808), as follows: "The specimen from which the photograph was taken was a full grown one received at the Aquarium in July [1911] from an unknown donor in Port Jefferson, Long Island. It lived for several weeks . . . and attracted much attention." Then he adds that "A number of cases of partial division of the caudal spine of the Horseshoe Crab (*Limulus polyphemus*) have been noted."

That such abnormalities of the straight tail of the horseshoe crab are more common than one would think, is also indicated in a note from Mr. C. M. Breder, Jr., Assistant Director of the New York Aquarium, who says:

> In the fourteen years that collections of Limuli [Xiphosuri] from New York Harbor have come under my observation, specimens with irregularities of the caudal spike have not been uncommon. While I have made no notes or paid any particular attention to these abnormalities, my memory has it that they may run two or three a year, or perhaps more. These have varied from very small subterminal branches to some that were bifurcated for approximately one-half their length. Generally there was considerable asymmetry displayed.

These malformations must be due to hurts to the caudal spine, probably received at the beginning of or during the molting or growing season. The spine appears at the second molt and gradually increases in length at each shedding of the skin. Yet, although the horseshoe crab sheds its skin like a crab, it is not a crab at all, but an aberrant member of the Arachnid or spider group! But that, as Mr. Kipling says, "is another story."

How "Pee-uk" Came to the Zoological Park

JACK ANGEL

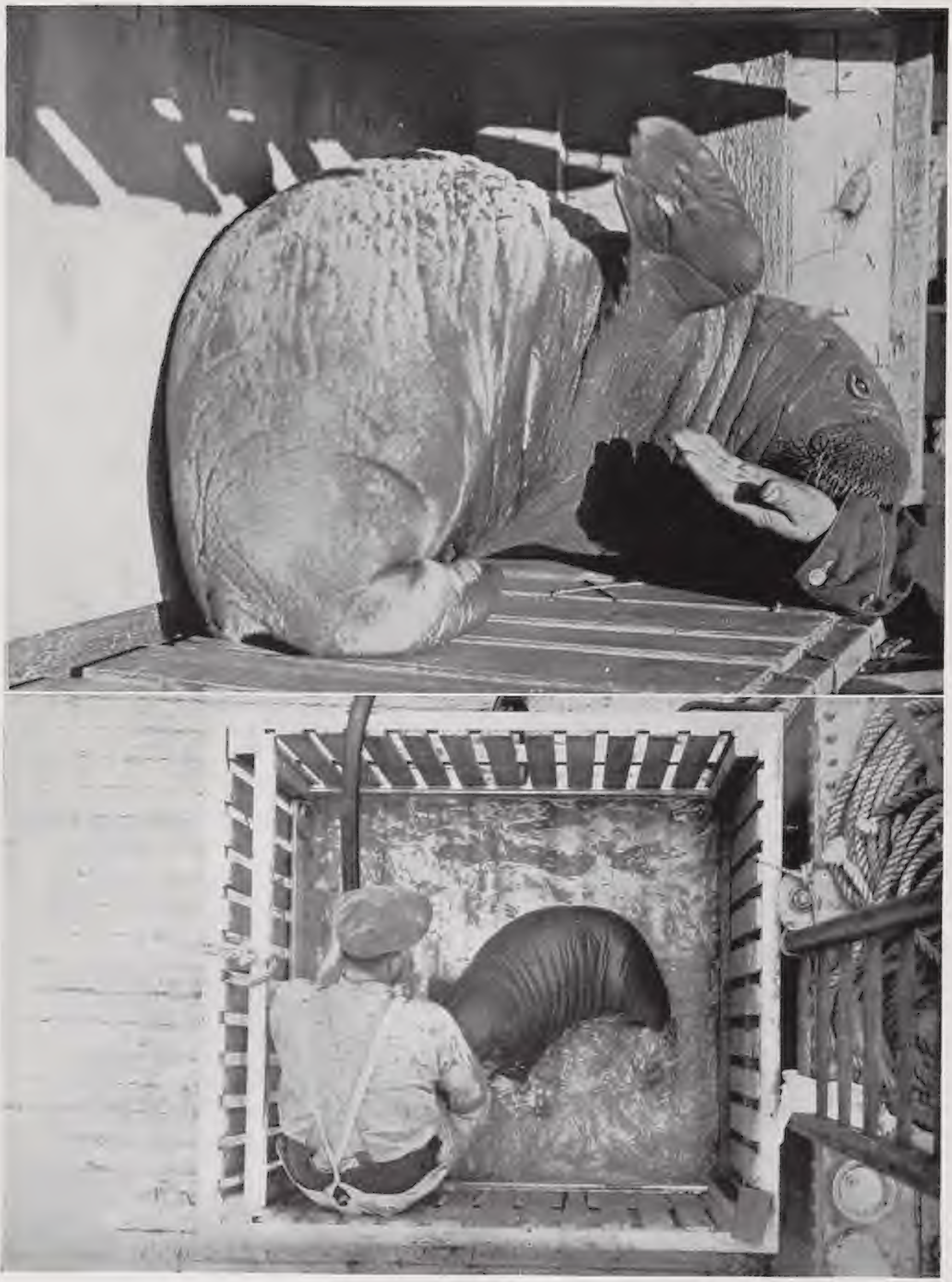
Photographer Aboard the Schooner Effie M. Morrissey

JUST at midnight on July 30, 1935, the Schooner *Effie M. Morrissey*, under the command of Captain Bob Bartlett, was making her way along the edge of the great paleocrystic ice floes that extended as far as the eye could see up into Kane Basin, completely blocking any further progress to the north. We had reached a point where the Canadian and Greenland shores were equidistant from us and only a few miles away. The Canadian shore was covered with snow and glaciers, cold and unwelcome. The Greenland shore which we had followed on our way north looked warm and inviting, its towering hills covered with talus at the base of which there seemed to be a little vegetation. In between the hills the glaciers wended their way back to the great Greenland icecap, the largest iceberg factory in the world. We had reached our "farthest north" for the year, and for a few hours were lying quiet, drinking in the peacefulness and sinister beauty of our surroundings.

As we skirted the heavy ice, we came upon a herd of walrus on an ice pan. Walrus often come up on the ice and if the sun is very warm they get sunburned. When found in this condition they actually have to be driven into the water. Then you will hear them cry and snort with pain. On this occasion, however, while the sun was high, it lacked the heat of the noonday and at our approach the walrus slipped off the ice and into the water, disappearing among the loose pans. One little fellow, however, became separated from the rest and the Captain was persuaded to lower the whale boat and go after it, for I suggested that we would be able to get some pictures of it on the morrow and could then let it go.

So with thrilled hearts we lowered the whale boat and went after the baby walrus. For perhaps half an hour we followed it in and out among the ice pans, for we could see it as it swam under water. Every time it came to the surface we would try to grab it and finally managed to get a boat-hook around one of its flippers. With eager hands we grasped its fore and hind flippers and hauled it into the boat.

The way the baby walrus wriggled and barked made us laugh so heartily that we almost lost him several times. We managed to get a spinning rope round his body, as one would harness a small dog, and on reaching the side of the *Morrissey* hoisted him, none too gently,



Photos by Jack Angel

Pee-uk not only enjoyed being petted; he demanded it. He made plenty of noise if his human playmates deserted him. Below he is shown getting one of his frequent wash-downs with salt water in the stout cage where he could soak and splash.

to the deck. Once aboard the baby was given the freedom of the ship, but to our dismay he was able to get his plump little body over the gunwale and had to be hauled back time after time. He barked continuously and I almost went on my hands and knees to him in my anxiety to make him stop, for the Captain was none too pleased about the noise. Several days before we had built a large crate for narwhal skeletons which we were bringing back to the Field Museum of Natural History at Chicago. In exasperation we put the walrus in the crate and tied the skeletons to the rigging.

To us on the *Morrissey* the baby walrus became known as "Pee-uk," an anglicization of the Eskimo word for "good." After association with the Eskimos for several weeks, everything, whether good, bad or indifferent, was termed "Pee-uk," so why not the baby walrus?

A few words from my diary of July 31 indicate how our troubles began with Pee-uk's first day aboard the *Morrissey*:

> In between whiles Pee-uk takes all my attention as I try to get milk down his throat by every possible means, none of which are very successful.

Naturally we tried feeding Pee-uk milk, for he indicated his willingness to suck one's fingers, but he did not seem to like the milk and our methods of feeding him were not at all what he wanted. We had no nipples. We first tried rubber fingerstalls, but with little success. Then we tried the rubber tube from a hydrometer, which was both too hard and too small. Writing from my diary of August 1:

> Got some ice for Pee-uk but he does not seem to be doing very well. Sores have broken out all over him and he is terribly lousy. Built a framework round the narwhal crate out of oil barrel staves, to keep him in. He does not like the nipple.

A few busy days followed and Pee-uk must have lived on his fat alone. We had little better success using the hydrometer bulb as a nipple. We did not take any pictures, as we hoped every day that he would begin to feed properly and then we could get some good ones. It was two weeks before that day came and then we were so fond of Pee-uk that we could not let him go. Writing from my diary entry of August 2: "—busied myself with Pee-uk, picking lice from him at regular intervals with a pair of tweezers. These lice are horrible things and dig right into his hide as do the lice on a pig. He takes very little milk but has lots of pep." And again on August 3: "He refuses to eat absolutely. Have tried milk (klim and condensed), fish and brewis, cereal, etc., and have used hydrometer bulbs, rubber fingerstalls and various other contraptions for nipples with little success."

On August 5 the end of our patience was reached and we decided to force Pee-uk to take nourishment. I noted in my diary of that day: "Pee-uk refused to eat at his meal hour today. Dressed in oilskins I got into the cage and wrestled with him, getting him over on his back and sitting on his fore-flippers. Len then jammed the bottle of milk down his throat. He had to take the milk or blow up. While most of the milk was spouted back in our faces we managed to give him about two pints." Len Gushue, the chief engineer of the *Morrissey,* is the happy father of fourteen children and his knowledge of babies and their whims was naturally very complete. We could not, however, persuade Pee-uk to eat sensibly. We realized that he must have clams or some other sea food.

But just what sort of sea food would be proper for a baby walrus? Len, the expert on milk for babies, was no help at all here and we were all perplexed about it. Just at this time, on August 8, our radio operator happened to be carrying on a casual conversation by short wave with an amateur station in Belgium and he mentioned that for a day or two we had been out of touch with a station in New Jersey through which we had arranged before starting out to transmit our messages.

The Belgian operator was helpful. He said he had a regular communication schedule with another New Jersey station, W2GOX, operated by J. E. Preston of 105 Prospect avenue, North Arlington. He offered to tell Preston to tune in on our wavelength so we could restore our line of communication with the United States.

A few hours later the *Morrissey* heard from Preston and then it occurred to us that here was a good chance to get some expert advice. We would have Preston telephone Dr. Blair at the Zoological Park and ask him what on earth we could do to restore Pee-uk's appetite.

So Captain Bartlett had our operator send the following message to Dr. Blair via Preston's station:

> Have a baby walrus on board which I want to bring to you. The little devil won't drink milk

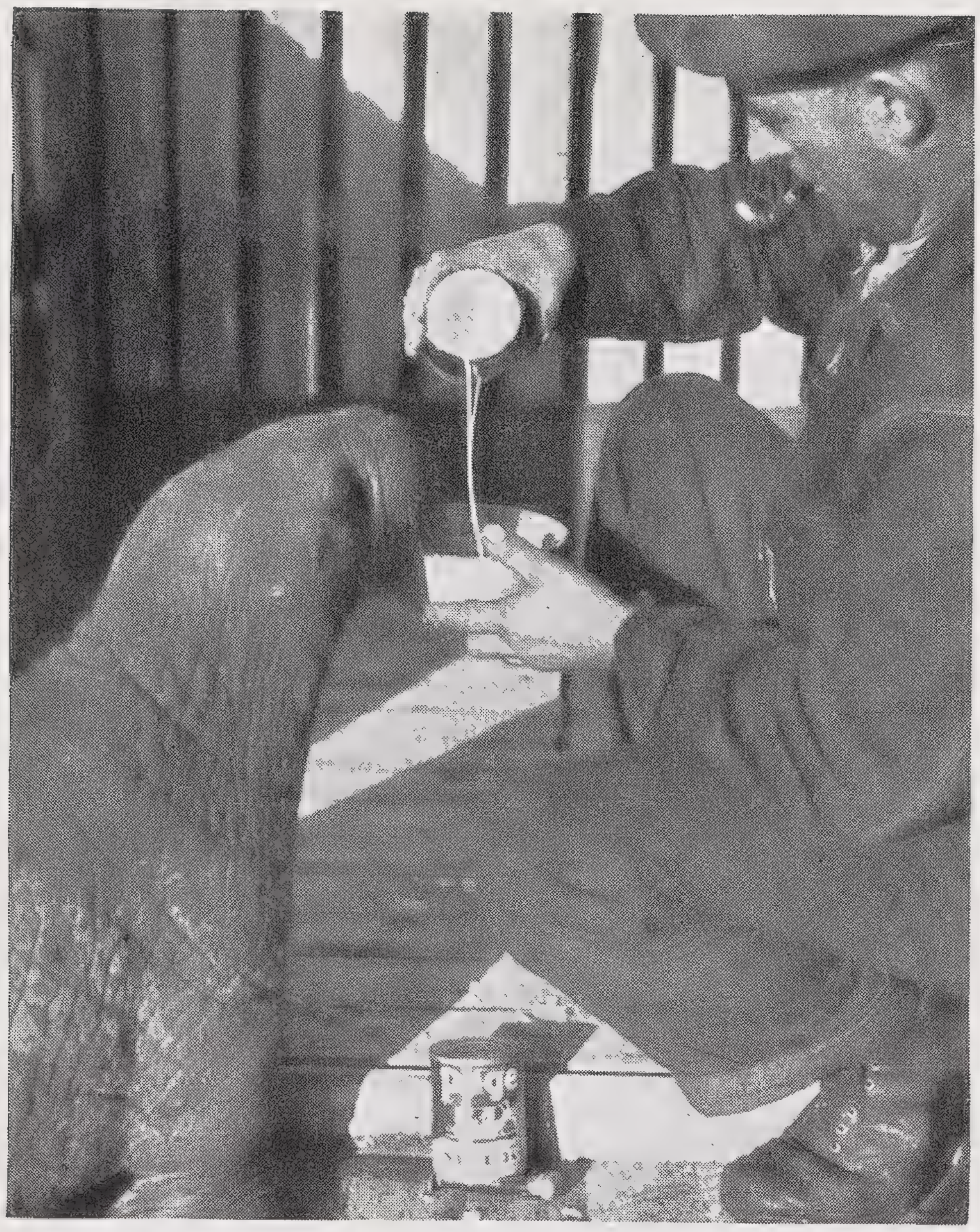


Photo by Jack Angel

Shredded codfish soaked in condensed milk turned out to be Pee-uk's favorite food when he began to eat regularly.

and we can't get him to eat only by force. Can you suggest method of feeding. Best wishes.

A few hours later station W2GOX flashed back this word from Dr. Blair:

> Feed walrus shredded codfish six times per day. Mash fish until semi-solid. Start with small quantity and if he does not vomit increase until he takes four or five pounds per day.

That was swell, but we had no fresh codfish aboard and would not be able to get any until we reached the Labrador coast several weeks later. However, Captain Bartlett is very fond of shore-cure Newfoundland salt codfish and there was a small quantity aboard. By this time the Captain had become so fond of Pee-uk that he was quite willing to donate his entire personal supply to the walrus.

Later we got a supplementary message from Dr. Blair suggesting that we vary the codfish diet with soft-shell clams, but of course we had none of those either, and Pee-uk seemed to be making out all right on the Captain's codfish.

The salt fish were cut up and well watered, first in salt water and then in several changes of warm fresh water. It was then shredded and pummelled and presented to Pee-uk. At first he was not at all interested but patience proved the victor and finally a dainty morsel was inserted between his toothless jaws. He sucked at it as children do macaroni. It seemed kind of dry, so condensed milk, right from the can, was poured over it. Pee-uk liked his new diet and we proceeded to follow Dr. Blair's instructions as closely as we could. Writing from my diary of August 9:

> Pee-uk likes the watered salt cod. Made a wooden platter for him but he prefers to eat from the hand. Really it is very amusing to watch him eat. He will come to the edge of the cage and stick his face out over the pailings. His eyes simply plead with one to give him something. Accordingly he is given a ribbon of fish, dipped in milk, and he will suck it in between his lips with great but reserved zeal. The look of absolute contentment on his face is lovely. While eating from the platter on the floor of his cage, he will lie out on his belly and allow his flabby snout to settle in the dish of food. Then there will be a sucking sound like a rubber clapper valve in operation and he will draw a piece of fish endwise into his mouth. His look now is one of embarrassment, for he seems ashamed to be seen in such an undignified position. He appears to be completely relaxed.

Shortly after Pee-uk came on board we discovered that he had lice or "cooties" with him. These annoyed him terribly on warm days or when he was wet. While picking these "cooties" from him with tweezers was very effective, it was not a very fast method, so we gave him a wash with Friar's Balsam. This gave Pee-uk a beautiful golden-colored coat but did not do away with the "cooties." Our bosun, a Newfoundlander, suggested stewing a plug of tobacco in a quart of water and washing Pee-uk with it. Such a mixture is used in Newfoundland to rid cattle of lice. To the stewed tobacco mixture I added some Friar's Balsam and gave Pee-uk a thorough washing. It did a grand job and when we landed him in New York he had very few, if any, "cooties."

At least several times every day, Pee-uk was given a good washdown with salt water, a procedure to which he looked forward with keen delight, except when he had a touch of sunburn.

At Turnavik, on the Labrador coast, we jigged about 250 pounds of lovely fresh codfish for Pee-uk and ourselves. The fish for Pee-uk was skinned and the bones taken out, after which it was shredded and mixed with condensed milk. Pee-uk loved this dish and readily ate from a wooden platter. He ate from seven to ten pounds of fish per day and it took a lot of time to keep him going.

At Brigus, Newfoundland, we stopped for three days, so Pee-uk was taken ashore and up to the lawn in front of Captain Bartlett's home. Here in the shade of the towering elms with the air laden with the perfume from the syringa and the hawthorne, he was able to roam around as he wished. The grass was moist and cool, and Pee-uk enjoyed his surroundings so much that he did not want to go back to the *Morrissey*.

Out from Brigus we ran into a real storm and Pee-uk behaved splendidly, which is more than one could say for the stomach of his keeper. Unfortunately, heavy seas washed away our supply of fresh fish and we had to fall back on the fish in the refrigerator which was for our own use. This too, soon went and then salt codfish again became Pee-uk's diet until we reached New York.

At Brigus we built a new crate for Pee-uk, in which he had lots of room to wander around. Several times every day we washed him with water from a hose and the tight bottom in his new cage held enough water to almost cover him. He would always put his head beneath the surface when the hose was turned on him.

Pee-uk is a lovely little animal and was a great favorite aboard the *Morrissey*. He loved to be petted as much as a child. Crossing the Arctic Circle coming south, continuous daylight gave way to periods of daylight and darkness. Darkness was a new experience for Pee-uk, and on dark nights he would become lonely and cry for someone to come and talk with him or to hold a leather boot or some rubber material in his cage so he could snuggle against it. He won our hearts, as I know he must win the hearts of all the children who see him. In Dr. Blair, into whose care we safely delivered him on September 4, at the Zoological Park, Pee-uk has a grand guardian. It was just twenty-five years ago this September that Captain Bartlett brought back "Flip," a baby walrus that lived for five years at the Park. It is a rather interesting coincidence that both Pee-uk and Flip should weigh 140 pounds on their arrival in New York, and twenty-five years apart, almost to the day.

Pee-uk's predecessor, Flip, also loved to be petted and demanded much personal attention from his keeper. He was likely to cry when he didn't get it.

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A Remarkable Collection

Aviculturists and others whose interest in the birds of paradise has led them to an examination of popular and scientific writings about "the most beautiful birds in the world" will recognize in the photographs that accompany Curator Crandall's article in this number of the Bulletin a collection of photographs that is probably unrivaled.

In all likelihood many of the birds pictured here have never before been photographed, at least with such clarity and detail. As bird subjects go, the birds of paradise were not particularly more difficult to photograph than many others, but few institutions approached the New York Zoological Park in the size of their collections and opportunity to get a really large series of photographs was thus lacking.

When Curator Crandall returned from New Guinea in 1929 with the birds that formed, and still form, the bulk of our collection, he and Mr. Osterndorff devoted considerable time to photographing them and obtained some excellent pictures which were reproduced in the Bulletin for November-December, 1929. Most of those pictures were taken while the birds were in a small cage with plate glass front and back and screened sides.

During the past spring it was determined to make a complete series of photographs of every bird of paradise in the Park and to that end one of the large cages in the Bird House was remodeled. Transferring the birds to the small cage that was used in 1929 involved some danger of frightening and injuring them, as well as a period of waiting while they became accustomed to the closer quarters and "settled down." Consequently it was decided to remove the coarse screen front of one of the large compartments already occupied by the birds of paradise and to replace it with plate glass.

A blind was then built of solid timber and composition board, painted black, and set up in front of the glass with apertures through which the camera could be pointed and the photographer could observe his subjects. After some experimentation, photoflash bulbs—one on each side of the blind—were found to be a satisfactory source of illumination.

The work of photographing the species, one after another, required some six weeks during which the photographer spent half the day or more patiently waiting inside the blind. The result speaks for itself.

Off With the Old

Like most snakes, the king cobra sheds his skin from five to seven times a year. Unlike most others, however, he seldom makes thorough work of it and eventually requires human assistance—which he generally resents and resists to the very end of the operation.

Other reptiles first loosen the skin about their heads and then literally crawl out of it, turning it wrongside out as they go, but the great Indian serpent usually scrapes off his loosened skin in long strips although sometimes the entire tissue-thin integument is cast in one piece.

Almost invariably the snake fails to remove the skin caps over his eyes and when two or more sheddings have occurred and the opaque covering still clings, an operation has to be performed.

Such an occasion arose in mid-August. Twice within the past four months the cobra had shed completely except for the eye caps and unimportant shreds of skin around the head. Both eyes were lustreless and for all practical purposes the snake was blind in his left eye and apparently able to make out only the vague

While Keeper Taggart held the king cobra's head against the side of the little cage, Dr. Ditmars inserted the point of the forceps under the dried eye-cap and one gentle pull removed it painlessly and quickly. The operation required but a few seconds.

outlines of moving objects with his right eye. As his blindness increased, so did his irritability and nervousness.

His irritability assisted Keeper Taggart in confining him in a small portable cage through the coarse screen sides of which the eye operation was to be performed. When the screen box was set in his big double cage in the Reptile House, the snake refused to enter it. By irritating him with a stick and then rattling the stick inside the box, Taggart induced him to crawl inside to investigate.

The operation itself was quickly performed—much more quickly than the preliminary of penning the snake in the small cage. With a flat stick the keeper pinned the serpent's head against the screen and while the long green body writhed and threshed Dr. Ditmars slipped the point of the forceps under the tough gray scale covering the eye, gave a gentle pull, and the cap popped off. The process was repeated for the other eye and in half a minute the king cobra's sight was perfectly and painlessly restored.

There were double caps on each eye, indicating that in his last two sheddings the snake had failed to remove that bit of his skin. The cap is not, of course, an eyelid. It is simply the thin and normally transparent outer layer of the cornea.

Two years ago a similar operation produced seven caps—four on one eye and three on the other. At that time the snake was almost completely blind, for while each single cap is clear, yellowish skin, three or four thicknesses stop all but the brightest light and, to the human eye, at least, are quite opaque.

In a state of nature the king cobra probably seldom has any difficulty shedding the caps over his eyes. Humidity, temperature, rough surfaces and all the other conditions that aid a snake in shedding are available to the serpent, whereas the conditions in a cage are necessarily only approximations of those in his natural habitat.

The African and the Indian cobras find cage conditions favorable and seldom have any difficulty in shedding. Sometimes their eye-caps remain attached for a few days after the rest of the skin has been shed, but almost invariably they pop off by themselves. The fact that the king cobra's eyes are relatively larger than those of the other cobras perhaps has something to do with his difficulties.

All the snakes in the Reptile House with the exception of those that have water tanks in their cages require a certain amount of personal attention when shedding time approaches. A good soaking enables the snake to shed easily, and at the proper time the keepers remove the snakes from their cages and drop them into a deep can with a few inches of water and a jagged rock at the bottom. Usually two days of soaking and scraping on the rock are sufficient and the snake is ready to go back on exhibition.

The signs of approaching shedding are unmistakable. The skin may appear dry and faded. The eyes become cloudy and bluish-gray. In a day or two the eyes begin to clear and return almost to their normal brilliancy. That is the sign that the snake is ready to shed, and he goes to the soaking tank.

Some reptiles require considerably longer than others to complete the process. The regal pythons are leisurely about it and may soak for two or even three weeks before crawling out of their tank and starting to rub the loosened skin away from their heads.

The big serpents generally attend to their own shedding, but some of the smaller ones require help even after a thorough soaking. If they are harmless it is a simple matter to take them up and gently work the soft skin back along the body. Forceps and restraining cages come into use when a poisonous snake gets into difficulties.

Unless they are frightened or angry, most snakes help their human assistant by "relaxing" and shoving against his hands. But if they want to obstruct assistance, they can do it effectively by contracting their bodies and seemingly holding their scales tight.

None of the shed skins retain any hint of the color that was in them when they were part of the snake, although some keep a faint silvery impression of the pattern. The Gaboon viper's natural colors are bold and striking and even his cast skin is handsome enough to be used as a decoration, although none of the actual color remains. The pattern may still be seen in a faint silver sheen against a sepia background. The puff adder, also, keeps a suggestion of pattern, and as a rule the heavier-bodied snakes are more likely to leave the stamp of their patterns on their cast skins than the slender-bodied reptiles. The diamond-back rattler's skin bears a mere tracery of its strong pattern.

Fragments or entire cast skins are often sent to the Reptile House for identification and the remnants of pattern are sometimes useful, if the locality in which the skin was found is stated. It is possible, of course, to identify almost any snake by its cast skin by means of a scale count, if the skin is perfect.

One difficult point, however, is the determination of the length of the living snake by the length of his cast skin. The skin stretches considerably in the process of shedding, and then shrinks when it dries. The skin of a 22-foot python may be 26 to 28 feet long when freshly cast. Even when it dries, it is likely to be a foot or two longer than the python.

Commercially the cast skins of snakes are worthless and they are not, as many persons apparently believe, used as "snake leather" in covering handbags, belts and shoes. The skin is too thin and fragile and the absence of color and design makes it useless.

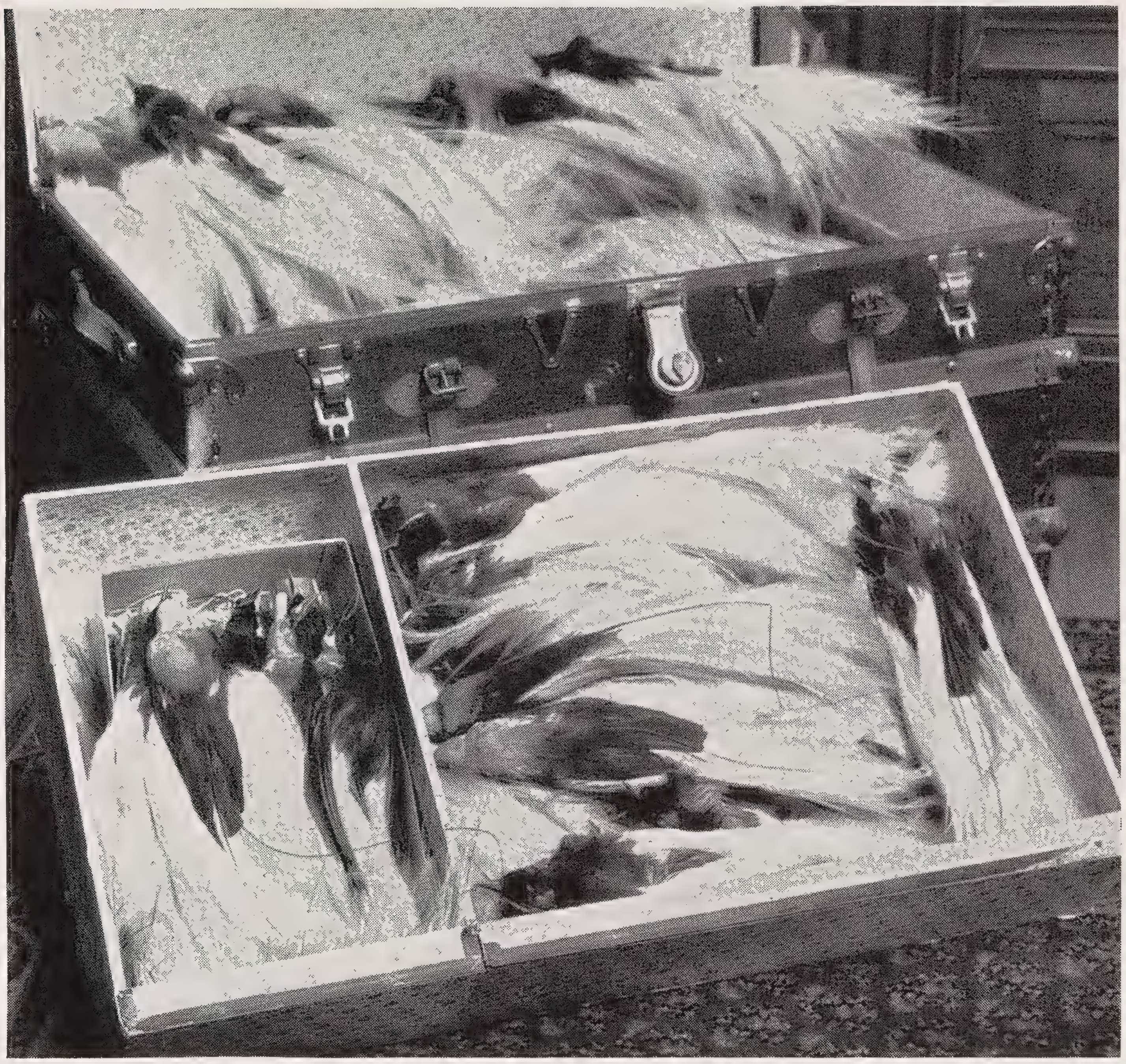
Contraband

Curator Crandall's statement in his article on the birds of paradise that virtually all species are now rigidly protected from plume hunters recalls an event of almost twenty years ago.

In the summer of 1913 Dr. William T. Hornaday through the Permanent Wild Life Protection Fund urged the Royal Zoological Society of Holland to press for complete protection of the birds of paradise that were being shot for the plumage trade. By 1915 all but three species were protected throughout the whole of the Dutch East Indies, but smuggling still continued.

The importation of bird of paradise plumage into the United States was forbidden by the plumage section of the tariff law, but feathers entered illicitly. Handlers of that kind of contraband got a severe jolt on January 29, 1916, when a trunk containing 527 birds of paradise was seized by customs officials at Laredo, Texas, as it was being smuggled into the United States.

A report on the circumstances was made to



Victims of fashion—527 skins of birds of paradise seized by the Customs authorities in 1916 when a feather dealer tried to smuggle them into the United States from Mexico.

Dr. Hornaday by Special Deputy Collector Edward Cotulla. He wrote:

> On January 3, 1916, this office received an entry for Immediate Transportation, in bond, without appraisement, No. 16399 from New York to Laredo, Texas, covering four cases of feathers (light plumes) marked A. K. Nos. 12-15, valued at £1,856 17s 10d, and consigned to A. Kallman, Mexico City, Mexico.
>
> On January 14, 1916, Warehouse and Immediate Export entry was filed for the four packages of feathers, consigned to A. Kallman, Mexico City, Mexico, the same being exported via International Foot Bridge on January 22, 1916.
>
> Prior to the exportation of the feathers, Mounted Inspector of Customs, Robert Rumsey, Jr., (to whom credit must be given for making the seizure), stated to the undersigned that he had information that four trunks of aigrettes were to be smuggled in from Mexico. I stated to Rumsey that in my opinion that was too many feathers of that class to come out of Mexico at one time, but that we had on file an Immediate Transportation entry from New York for four cases of "light plumes" and that probably these would be sent to Mexico and then smuggled back into the United States.
>
> Rumsey was instructed to get busy and find out if possible through his informant if the feathers in bond from New York were to be taken to Mexico, and then brought back; which Rumsey found was really the intention of the owner.
>
> As above stated, the four cases of feathers were exported, and entered at the Mexican Custom House of New Laredo, Mexico, duties being paid thereon.
>
> After being released by the Mexican authorities, the four cases of feathers were packed into a trunk which had been taken from Laredo, Texas, for that purpose. On the night of January 28, 1916, the trunk containing the supposed light plumes was smuggled across the river from Mexico, and placed in a house.
>
> Mounted Inspectors Robert Rumsey, Jr., and John C. Chamberlain kept the house under constant surveillance until about 7:00 P. M., January 29, when Mr. Abraham Kallman went to the house after the trunk.
>
> Rumsey was instructed by this office to let the party coming after the trunk get actual possession of it before any arrest was made. Mr. Kallman was allowed by the said Mounted Inspector to go to the International & Great Northern Depot, which was about two miles distant from the place of concealment, and he was in the act of getting this trunk checked to leave on the 8:00 P. M. train for San Antonio, and thence to St. Louis and other points, when he was placed under arrest.
>
> Mr. Kallman was brought to the Customs House that night, where he acknowledged that the trunk contained the birds of paradise that were taken across to Mexico a few days prior. Letters, and a statement, under date of December 15, 1915, were found in Mr. Kallman's possession, showing that he bought the birds of paradise from Benjamin, Williams & Company, of London, England, but they were originally shipped from British India. His correspondence showed previous dealings in feathers with the same firm.
>
> At final trial before the U. S. District Court, Mr. Kallman pleaded guilty and was sentenced to serve six months in Webb County jail at Laredo, Texas, and pay a fine of $2,500.00. He served his time, and paid the fine through the American Surety Company of New York. The birds of paradise were forfeited to the United States, and ordered sold by the judge. The U. S. Attorney filed an appeal, which was heard at New Orleans, La., the judge ordering the birds turned over to the Treasury Department for disposition.

That seizure of bird of paradise plumes, commercially valued according to the owner's declaration of "light plumes" at more than $9,000 and by later statements at about $52,000, was the most important seizure of illegal plumage made up to that time under the law prohibiting such importations. The seizure left the Treasury Department in possession of a problem, however, as to what to do with the plumes. Protests poured in from all over the country when they were first ordered destroyed.

Eventually it was decided by the authorities to turn the entire shipment over to the New York Zoological Society through which some of the finer skins could be distributed to museums for mounting. This was done, and the remainder of the tragic cargo is still in the possession of the Society, preserved in the trunk that crossed the Mexican border on that January night a score of years ago.

An Almost New Studio

The photographic department of the Park has been in nominal possession of an animal portraiture studio for almost a quarter of a century—since 1911, in fact. Actually the commodious room set aside for indoor photographic work at the south end of the winter pelican house in the Service Yard has been of comparatively little practical use in all those years because of varying light and heat factors.

On the theory that natural daylight is the ideal condition for fine photographs, the studio was built with a glass roof and a glass south wall. The result was so much natural daylight that, when the summer sun was beating down on it, the studio was virtually uninhabitable by either photographer or animal subject. Snow and gray days in winter created another problem that was almost insurmountable.

During the past summer the glass roof was removed and replaced with a double roof of wood and composition board, with an air space for resistance to solar heat, and a louver was set in the roof for ventilation. The south wall was replaced with brick and mortar.

The studio was thus made practically light-tight except for two small windows on the east side and a powerful battery of electric lights was installed to do the work of daylight. At present, from an overhead trough light, two bunch lights and a spotlight, 9,500 watts of incandescent lights can be concentrated on the big table where the animal sitters are posed.

Mr. Osterndorff is still experimenting with the illumination to determine its full photographic possibilities, but it appears to be more than adequate for many subjects and it is hoped that it will be the means of adding many new negatives to a collection that is now approaching the 15,000 mark.

Baby Sea Lion

Entirely unheralded, and greatly to the surprise of most members of the Zoological Park staff, a baby sea lion was born in the Baird Court Pool on June 1. The several other young sea lions previously born in the Park failed to survive for any length of time and we have at hand no records of any young captive-born sea lions living to maturity. So this event was especially interesting.

All efforts were made to assure the well-being of the new arrival. The pool was partly drained to furnish shallow water at one end and this section was fenced off as a private area. A special basking ground was constructed so that daily sun baths would be available to both mother and offspring. The mother intelligently accepted these changes and took excellent care of her baby, jealously guarding him against all attentions from other residents of the pool. Occasionally a too-inquisitive sea lion managed to enter the private quarters but was immediately driven over the fence, just ahead of the mother's sharp teeth. The intruder's frantic haste to escape was always enjoyed by the crowd of visitors lining the pool enclosure.

From the very first, the young sea lion gave the impression of possessing a bountiful share of health and vigor. Usually hungry, his zestful, smacking lips could be heard all around the pool. His growth and general physical development were marvelously rapid. Within a month he had forsaken the basking ground for the large island in the west end of the pool and began making short excursions 'round about on his own initiative. His dexterity in the water and general ability to take care of himself soon became so apparent that the fence was removed in order to give him the full range of the entire pool.

At this writing he weighs perhaps three times as much as when born and seems to be as completely at home in the water as any of the adult sea lions. But he is not yet weaned. Fresh fish have no attraction for him and we are looking forward to the time when his liquid diet will be forsaken in favor of our daily offering of butterfish. Not until then will he seem to be really grown up.

C. W. L.

The Fleetest Animal

Up to a quarter of a mile or maybe even half a mile, a cheetah is the fastest animal on earth. Nobody seems to have held a stopwatch on one as it bounded over the plains of Africa to overtake an antelope, itself a creature that has become a simile for extreme speed, but it is generally agreed that on short spurts it holds the animal track record.

More than half a mile, and the hunting-leopard wearies. "Their bolt is soon shot, and on the open plain they can readily be galloped down with a horse," Theodore Roosevelt noted in "African Game Trails."

It needs to be fast, for its common prey—gazelles, steinboks, oribis—can outrun most other predators. Roosevelt observed that cheetahs sometimes bring down half-grown hartebeests and young kudus and waterbucks. Since the animal has non-retractile claws, like a dog, it has to depend largely on its teeth and its leaping attack for bringing down food.

The scientific name of the cheetah is *Acinonyx jubatus* and there is only one living species. Mature males are slightly larger than the females, but there are no color differences between the sexes. The animal ranges rather widely, from the Cape of Good Hope north through eastern Africa and the Nile Valley to Arabia, Persia and India.

A magnificent pair of cheetahs came to the Park on August 9 and are now on exhibition in the Lion House. The male is probably about full-grown but the female is still immature. When they arrived the female required regulation of her diet and was kept in the Hospital for a few days, while the male was put on exhibition immediately. A proper diet was soon determined and the female joined her mate in the Lion House. They were wary of each other for a few minutes and stood on opposite sides of the cage uttering their shrill, whistling note. Then the male stalked over, cuffed his mate a few times, and went to sleep without more ado.

The London Zoological Gardens was probably the first institution of its kind to exhibit a cheetah. Its records show that a specimen was purchased for its collection on May 11, 1829.

Being more amenable to human control than most cats, despite an individual variation in temperament, the cheetah has long been trained in India as a hunter. At least one attempt has been made to adapt the animal to hunting conditions in this country. Guests at the dinner of the American Game Conference last winter were amused by a motion picture of a cheetah employed as a duck retriever. Breeders of bird dogs do not need to fear the competition of the hunting-leopard, however. The cheetah was willing enough to fetch game that fell on dry land, even though it was reluctant to give up the birds, but cat-like it drew the line at wetting its paws to recover from the water.

New Snake Book

Ever since it was first published in 1929 as a complete number of the BULLETIN, Dr. Ditmars' comprehensive yet compact guide to the snakes of the northeastern States has been in constant demand. Two large editions have been exhausted and orders continue to flow into the Reptile House—a sure indication that the booklet meets a very real need for a handy, accurate, well-illustrated manual of the twenty-one species of poisonous and non-poisonous reptiles in the area roughly embracing New England, New York, New Jersey and eastern Pennsylvania.

There is, as a matter of fact, no comparable publication on the snakes of the northeastern States and because it is obviously wanted by campers, picnickers, and all who wander afield, the guide has been revised, somewhat enlarged and reissued under the title of "Serpents of the Northeastern States."

In its new form the guide will be found even more useful than in the past. Its sixty pages contain forty-one illustrations, two of them showing the timber rattlesnake and the copperhead in accurate color. Every species of serpent found in the area under discussion is pictured. There is a non-technical key for the immediate identification of snakes, a description of the feeding and breeding habits and range of each species, a chapter on the treatment of snake-bite and a bibliography of publications about snakes.

"Serpents of the Northeastern States" is on sale in the Park and by mail at 50 cents a copy, postage included. A companion publication, a number of the BULLETIN, on "Poisonous Serpents of the New World," also by Dr. Ditmars and fully illustrated, may be obtained for 35 cents.

The Reptiles of China

THE REPTILES OF CHINA. By Clifford H. Pope. Natural History of Central Asia, Volume X, 1935. 604 pages with 78 illustrations in the text, including a map and 27 plates. Published by the American Museum of Natural History. $10.

Summarization of the broad scientific achievements of the American Museum of Natural History's Asiatic expeditions is steadily appearing in a series of imposing volumes. The latest contains the fruits of intensive study of the reptiles of China—the turtles, crocodilians, snakes and lizards. It is a collective arrangement and description of all the known species occurring in that far-flung country.

The value of this up-to-date and extensive presentation can be imagined even without examination of the work. The brilliant young herpetologist of the expeditions under Dr. Andrews' leadership has completed a great task and a notable one. The Museum may well take pride in adding this volume to its Asiatic series.

The author arrived in China in June of 1921 to join the field staff already assembled for the third expedition. He was provided with extensive collecting equipment and in July he started for the Tungling region where he took up the study of Chinese. Some of his early reconnoiters were in isolated patches of forest in areas generally denuded by lumbermen. Reptiles were found to be fairly numerous where the forests remained. It was early in his collecting work that he found that a study of rural Chinese psychology was as necessary as a knowledge of the language.

"In approaching a farmer for information," he says, "one should not make abrupt, specific inquiries, because the oriental farmer, for all his rugged appearance, is in some ways a polished gentleman whose mind must be tactfully directed toward the desired subject."

In examining the book I naturally turned to the portion dealing with the snakes. That part, alone, covers 355 pages and includes many figures to show scalation and pattern. Synonomy has been very satisfactorily presented, with clarification in a number of instances. The treatment of the respective species and subspecies includes, under subheadings, detailed description, distribution, habits and general remarks. The latter grouping incorporates much material from field notes as to situations in which various species live, and examinations of stomach contents. Other notes, some gathered from other observers, bring to the reader's attention points easily overlooked in the mass of general literature, much of it from foreign sources.

It is interesting to note that the king cobra is markedly diurnal, that it deposits from 21 to 33 eggs, that the female utilizes a sort of nest by laying the eggs on a pile of leaves or vegetable rubbish where she remains on guard during incubation, while the male may also stay near the eggs. There are field notes regarding the wide distribution of a black subspecies of the Indian cobra in China. It is of interest to read that the sea snake, *Microcephalus gracilis,* feeds on eels. This is one of the strangest of the sea snakes, having a powerful, bulky body and an incongruously small head approximately one-tenth the vertical diameter of the body. The species is figured among the plates.

Treatment of the genera *Agkistrodon* and *Trimeresurus* brings much to light. These snakes have long warranted detailed study, both genera, strangely enough, having a few allies in the New World.

Pope's work will take its place beside the volumes of Boulenger in my library. Herpetologists have long wondered who would some day attempt the monumental task of revising the catalogue of the world's reptiles, and "The Reptiles of China" constitutes a considerable chapter along these very lines. Its voluminous and modernized nomenclature, including many of the Indo-Malayan forms, with ranges extending easterly and northerly, will be considered of great value to herpetologists other than those specifically interested in the fauna of China.

R. L. D.

PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-IX and XI-XVIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Some Books by Members of the Park Staff:

Beebe: HALF MILE DOWN. 344 pages, 123 illustrations and 8 colored plates. 1934. $5.

An account of the deep-sea explorations of the Department of Tropical Research in the bathysphere.

Blair: IN THE ZOO. 195 pages, 55 illustrations. 1929. $2.50.

Entertaining and informative animal stories drawn from long experience in the Zoological Park.

Crandall: PARADISE QUEST. 226 pages, 52 illustrations. 1931. $3.50.

A vivid description of a successful expedition to New Guinea in search of Birds of Paradise for the Park collection.

........: PETS AND HOW TO CARE FOR THEM. 296 pages, 96 illustrations. 1930. $2.

A practical manual for everyone who keeps animal or bird pets.

Ditmars: CONFESSIONS OF A SCIENTIST. 241 pages, 39 illustrations. 1934. $3.50.

Adventures in collecting and maintaining animals in the Zoological Park.

........: SNAKES OF THE WORLD. 207 pages, 84 pages of illustrations. 1931. $5.

A comprehensive book of reference on the snakes of the world.

Leister: PRESENT DAY MAMMALS. 74 pages, 105 illustrations. 1931. $1.

A valuable classification and reference book for schools and students of zoology.

All these books and others by the same authors may be obtained from the New York Zoological Park. For book express add 15 cents postage for each volume.

A classified list of the publications of the Society, with subject headings of articles printed in the *Report, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. MITCHELL, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

Clark and Fritts, New York, Printers.

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BULLETIN
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EVER since its founding in 1895 the New York Zoological Society has attracted the active interest of persons who believe, with the founding group, that instruction and entertainment and important scientific achievement can go hand in hand through the maintenance in New York City of well-balanced collections of mammals, reptiles, birds and fishes from all parts of the world.

The Society is taking a prominent part in the conservation of wild life all over the world but especially in North America. The work it has done in the collection of Heads and Horns is of great scientific value, as are the accurate pictures of wild life in its galleries.

In the Society's work of gathering, maintaining and exhibiting its collections, as well as its constant efforts in behalf of conservation of wild life everywhere, every Member shares, and through the privileges of Membership and the Society's publications is rendered an accounting of the work in which he participates.

The New York Zoological Society invites the Membership of all persons who wish to lend financial support to the purposes for which the Society was founded and to cooperate in a tangible way toward the future development of the Zoological Park and the Aquarium.

Annual Membership in the Society is $10, renewable annually. Life Membership may be obtained for $200. A contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

All classes of Members are entitled to receive every periodical publication, the privileges of the Administration Building with its lounges and reception rooms and gallery of paintings of animals, to attend lectures, open meetings and entertainments, and to be admitted free to the Zoological Park and the Aquarium every day in the year.

Application for Membership may be given to the Director of the Zoological Park or the Director of the Aquarium, or may be mailed directly to the Secretary, New York Zoological Society, 101 Park Avenue, New York City, for action by the Executive Committee.

The Zoological Park is open every day in the year from 10 o'clock in the morning to one-half hour before sunset. Admission is free every day except on Mondays and Thursdays when an admission fee of 25 cents is charged for adults and 15 cents for children between the ages of five and twelve. These days have been set aside primarily for the benefit of Members and their friends who are admitted free on tickets issued with Membership, so that the collections may be seen to the best advantage. All holidays are free.

The Aquarium also is open every day in the year. From April 1 to September 30 its hours are 9 o'clock in the morning to 5 o'clock in the afternoon, and for the remainder of the year, from 9 o'clock in the morning to 4 o'clock in the afternoon. No admission is charged.

Somewhere along the rough Bermuda coastline, among ledges such as these, the remnant of the once mighty flocks of cahows still combats utter extinction.

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Rediscovery of the Bermuda Cahow

An "Extinct" Bird Is Still Breeding Somewhere Along the Rocky Coast

William Beebe

THE resurrection of a living creature, which is supposed to be extinct, is of far greater dramatic interest and actual scientific value than the mere naming of a new species. The 1935 Bermuda expedition of the Zoological Society was fortunate enough to make such a discovery.

Somewhere, on some outlying islet of Bermuda or in the crevices of an unclimbable cliff, there still exists a pitiful remnant of a species of sea-bird, the last surviving group of its kind in the world. They are petrels or shearwaters and almost from the first settlement of man in these islands have been called cahows, which is a very feeble onomatopoeic attempt, the voice of these birds possessing a wild, haunting quality quite impossible to express in human syllables.

In 1603 the galleon of the Spanish Captain Diego Ramirez was driven by a terrible storm into a Bermuda harbor. Ramirez writes:

> The headlands are undermined at water level with the haunts of nocturnal birds, which remain in their caves by day, but come out at night to feed on fish, especially on squid of which there are great numbers. These birds sally forth at nightfall with such an outcry, and varying clamor, that one cannot help being afraid, until one realizes the reason.
>
> The first night that I anchored in the bay, I sent a small boat to an inlet to look for water, but none was found. At dusk, such a shrieking and din filled the air that fear seized us. Only one variety of bird makes this noise, but the concerted yell is terrible, and standing out from it were individual voices shouting diselo! diselo! (tell 'em, tell 'em). One seaman said to me: "What is this devil trying to tell me? Out with it! Let's hear what it is!" I replied: "A la! These are the devils reported to be about Bermuda. The sign of the cross at them! We are Christians!" While we were in this confusion, the men of the small boat rushed up, exclaiming in their alarm, "What devils are these? The boat's rudder is broken." I ordered another to be made immediately, because in the morning the coast had to be searched for water. One Venturilla, a negro, was sent on shore with lantern and axe to cut a piece of cedar. The moment he landed and entered the bush, he set up such a yell, that I shouted: "The devil's carrying off the negro! Everybody ashore!" The men jumped into a boat and rushed to the spot, where the negro was brandishing his lantern and his fists against the birds, and mingling his yells with theirs. The birds, meanwhile, attracted by the light, dashed against him, so that he could not keep clear of them even with a club. Neither could the men of the relief party. More than 500 birds were brought off to the ship that night, and, having gone through hot water and been plucked, proved to be very fat and fine. Thereafter a capture was made every evening. The birds were so plentiful that 4000 could be taken in a single bag. The men relished them enough to eat them all the time, and when we left we brought away more than 1000 well dried and salted for the voyage.

This is the first extant mention of the cahows. After the landfall of Sir George Somers, we have several additional accounts of their vast numbers and the methods of capture. William Strachey, Secretary-Elect for Virginia, tells us in 1610:

> Our men found a prettie way to take them which was by hollowing and laughing, with the noyse thereof, the birds would come flocking and settle upon the very arms of him that so cryed: by which our men would weigh them and which

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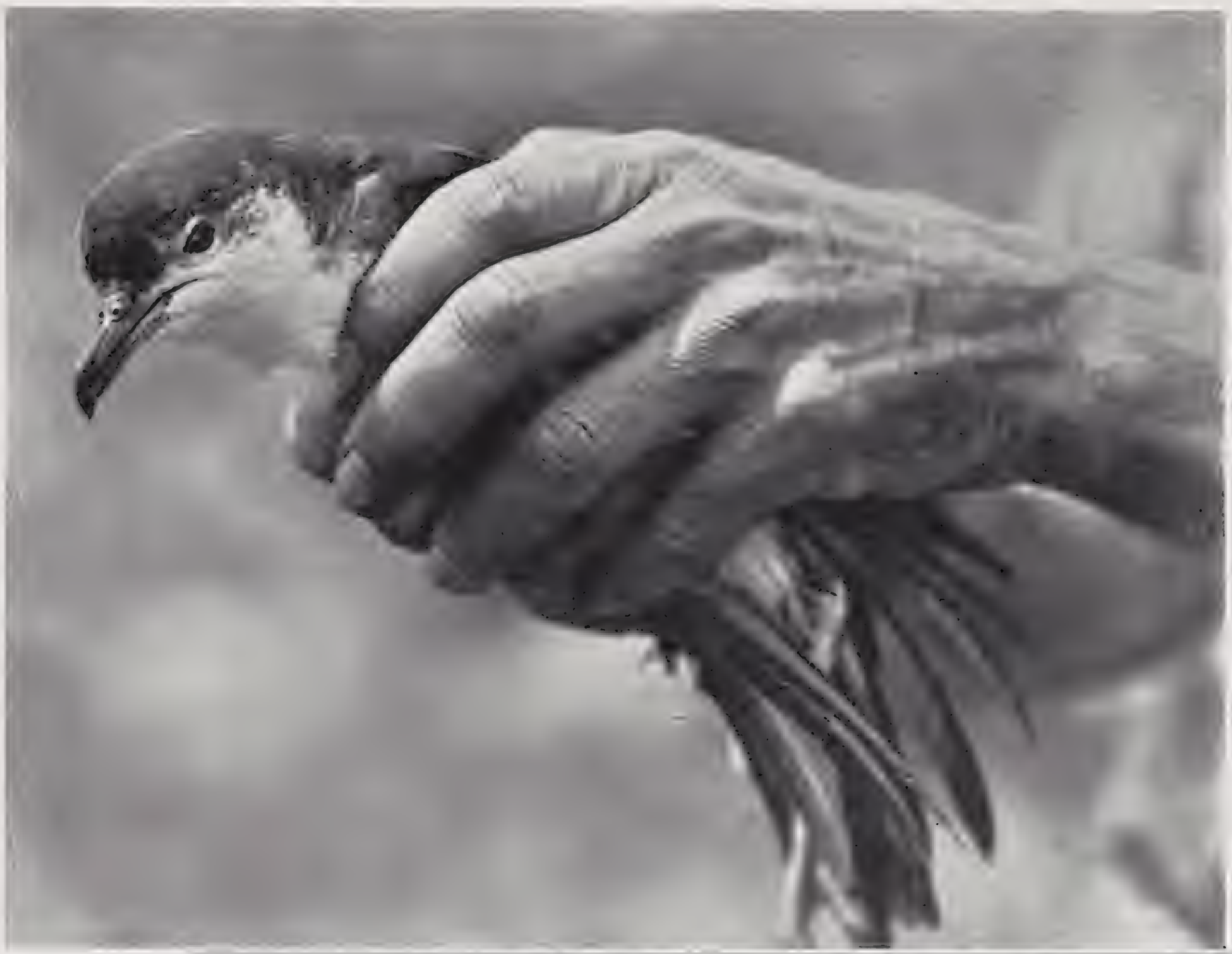
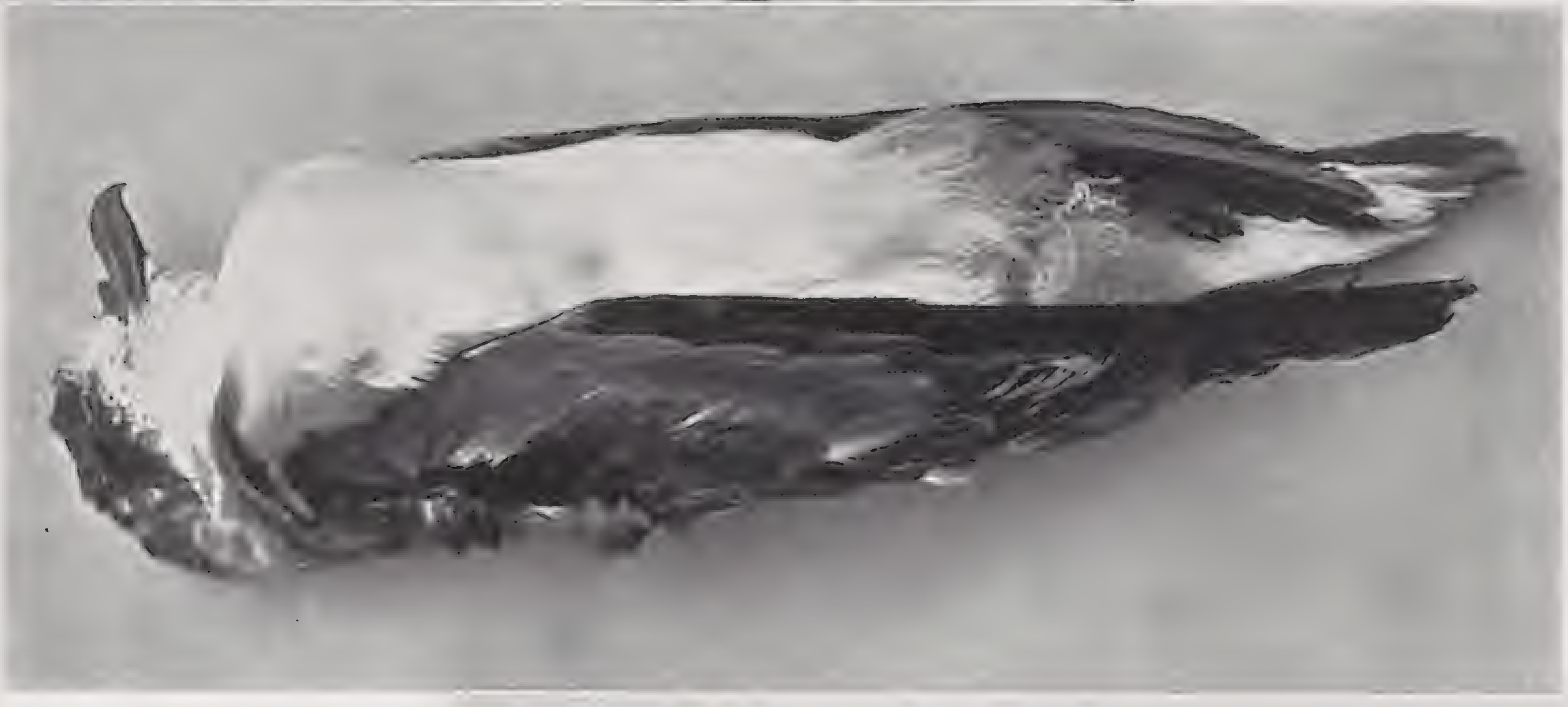
The photographs illustrating the rediscovery of the cahow and the résumé of the work of the Department of Tropical Research were taken by John Tee-Van.



At the left is a full-grown Audubon's shearwater, taken from its nest among the Bermuda cliffs.

(Below) The second known specimen of the Bermuda cahow—the young bird that dashed itself to death against a lighthouse. Note its resemblence to the Audubon's shearwater above.



Dr. Beebe is holding a young Audubon's shearwater, beside the nesting crevice where it was found. The bird is erroneously called a "cahow" by the Bermuda fishermen.

weighest heaviest they tooke, twentie dozen in two hours. In January wee had great store of their egges, which are white and as great as any hennes. They breed in those islands which are high and there in the ground have their burrowes. These birds will bite cruelly with their crooked bills.

Shakespeare in the same year, 1610, read Strachey's account and we find in "The Tempest" several suggestive lines, such as "I'le get thee young Scamels (i.e., sea mews) from the Rocke."

Lewis Hughes, a preacher, wrote to London in 1614 that "The Cahouye continued til the beginning of June in great abundance," but two years later Governor Daniel Tucker passed a " 'Proclamation against the spoile of Cahowes,' but it came too late, for they were most destroyed before."

This appears to be the last mention of the cahow, after which they seemed to have suffered that obliteration which is so often a result of man's increasing dominance of the earth.

Two hundred and ninety years later, on February 20, 1906, Louis L. Mowbray, Director of the Bermuda Aquarium, found a bird in a rock crevice, about twenty feet above high water, on the southeast side of Castle Island. This was a shearwater, sufficiently distinct to deserve a new name. It was described by Nichols and Mowbray[1], and today stands as *Pterodroma cahow.* It had the general shearwater pattern of dark brown above, forehead and all the underparts white. Its specific peculiarities were a relatively small white spot above the tail formed by the basal halves of the tail-coverts and the absence of a distinct, lighter nape and hindneck between the darker crown and back. Its length was 14¾ inches, and it had a wing spread of 35 inches[2].

Next in the history of the cahow came a false alarm on my part. Late in nights of spring on Nonsuch Island strange voices would come in from the sea, not to my ears "harsh howlings" but a harmonious, sweet Wheeo-o! Wheeo-o! I found[3] that these were Audubon's shearwaters, nesting in the crevices of the rock and coming out to feed at night.

The discovery that this shearwater still bred in Bermuda was interesting enough in itself and the fact that the Bermuda fishermen still knew them as cahows led me to think that this species might prove to be the old cahow which had existed in such great numbers, centuries ago, in this very locality. But proof to the contrary was furnished by the abundant remains of semi-fossil bones found in the limestone caves and in the strata exposed in deep road cuts made from time to time. These remains are unquestionably those of the historical bird and when they were measured and compared with my Audubon's shearwater, their larger size confirmed their identity with the single recent bird taken on Castle Island. These fossil bones have been found many feet below the surface, buried in a layer of aeolian limestone which was deposited beneath the second fossil soil, some twenty-five thousand years before Sir George Somers was ever wrecked on the "still-vex'd Bermoothes."

Aware of my interest in all unusual living creatures in these islands, Mr. O'Connor, the light-house keeper on St. Davids, sends me any strange birds which are killed against the glass on nights of storm. On June 8 of the present year a parcel was delivered by a boy on a bicycle at New Nonsuch, and proved to contain a dead petrel. My ornithological library in Bermuda is very limited, in comparison with the extensive one devoted to fish, and I was unable satisfactorily to identify the bird. So I sent it to Dr. Murphy of the American Museum and excited word came back that it was the second known specimen of the real cahow or Bermuda shearwater, *Pterodroma cahow* Nichols and Mowbray.

Judging by the well-ossified skull, I thought that this young bird must have been a month or more on the wing, but Dr. Murphy assures me that it was probably only a few days out of the burrow or nesting crevice.

When shearwaters are about two months old, Dr. Murphy tells me, they are abandoned by their parents. At this time the down on their bodies has almost disappeared, and these spatial orphans starve in their burrows for about twelve days, subsisting on the excess fat of their bodies. During this time they scramble forth at night, and creep or hop about their rocks, returning about 2 A.M.

At the end of this period of fasting they plunge off the cliff into the water, or if there is a strong wind, launch out into the air. Then

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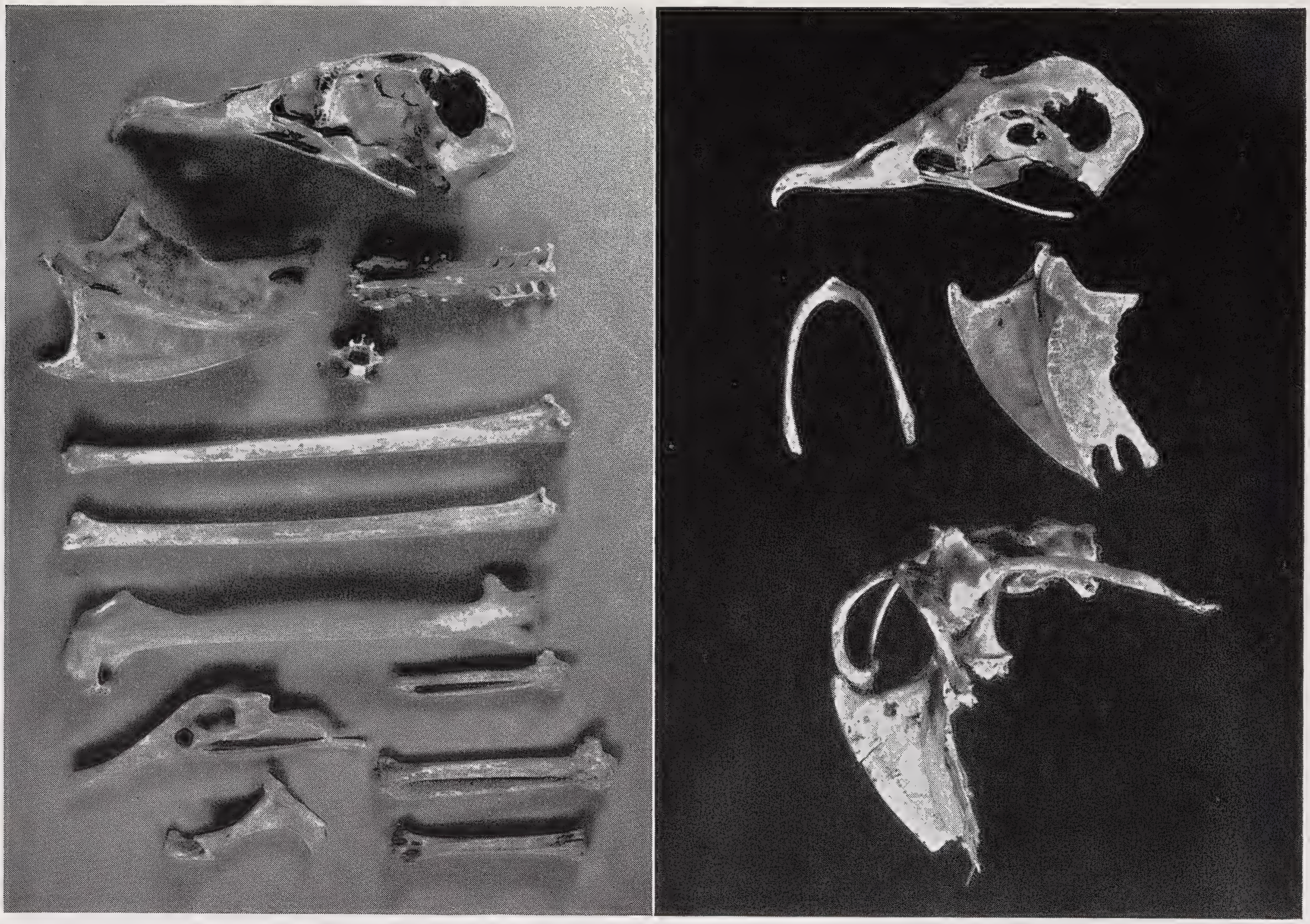
[1] First named *Aestrelata cahow. The Auk*, Vol. 33, p. 194.

[2] The various measurements in millimetres were as follows: length 375, wing 260, spread 889, bill 29, tarsus 40.

[3] *Nonsuch: Land of Water*, Chapter IX.



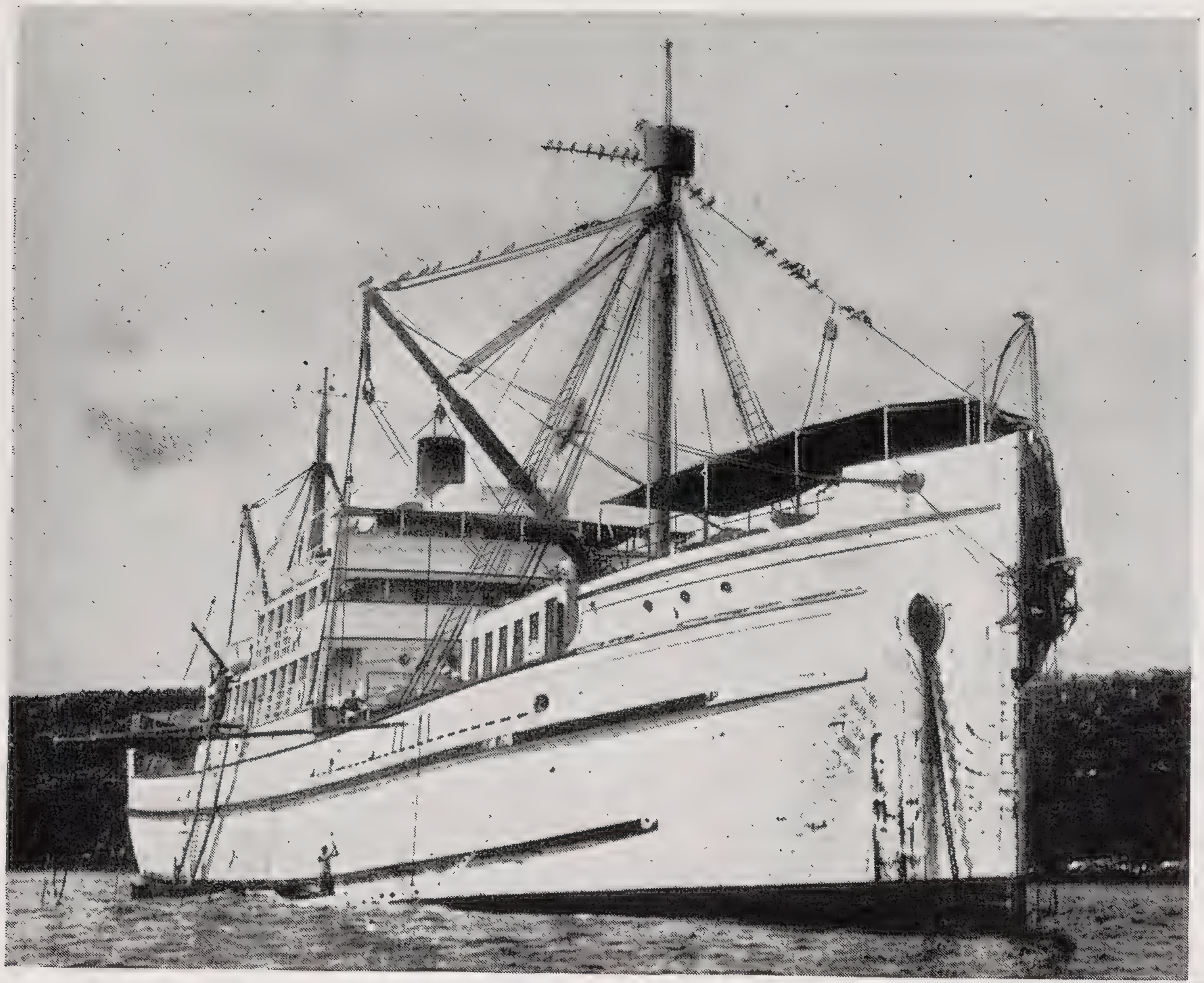
(Left) Fossil bones of the cahow that once existed in vast numbers in Bermuda. (Right) The three upper bones are semi-fossil remains of the cahow, buried in the limestone for centuries. The lower skeleton is that of the rediscovered cahow.

weeks are spent, swimming for the most part, collected in dense flocks before they begin their all but aerial life. My bird must have been fairly strong on the wing to reach the height of the light-house glass, yet too young to swerve from its path.

When I realized the great scientific worth of the specimen my mind went back to the skeleton. Mr. Tee-Van had skinned the bird for me, and had no recollection of what he had done with the body. As I thought at that time it was some well-known species, I had felt no concern about saving the trunk bones. About a month after this we were getting a wicker fish trap ready for use when I noticed a small cluster of well-cleaned bones inside. My artist, Mr. Swanson, saw them at the same moment, and exclaimed that they must be those of the cahow, as he recalled, a month before, throwing the fresh body of the petrel into the trap with other bait and then dropping the whole overboard. Examination showed the entire trunk, vertebrae, furcula and breast-bone to be intact and beautifully cleaned by fish and water. So the only known recent skeleton of this species was retrieved.

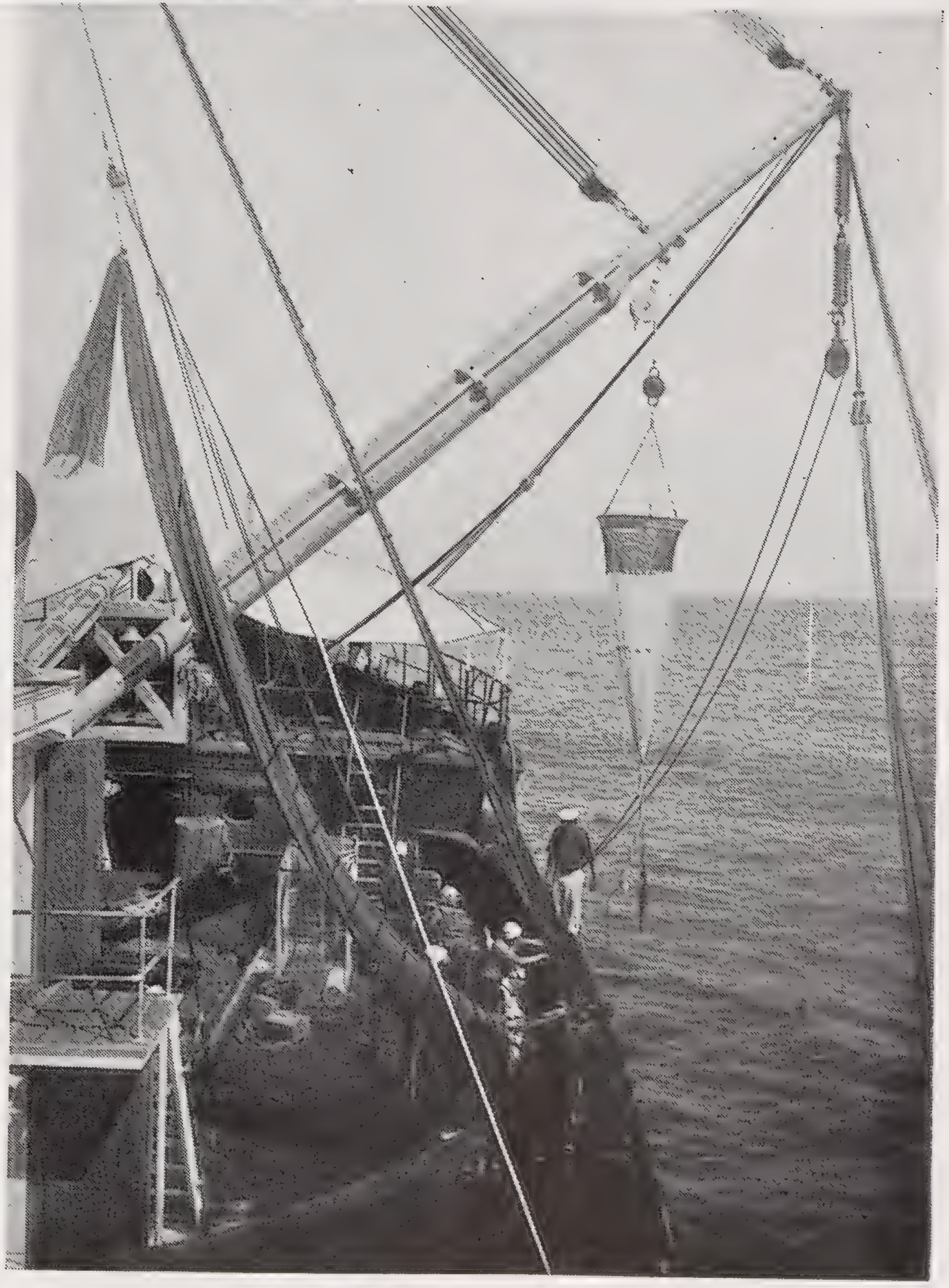
Fortunately the bird preservation laws of Bermuda are thorough and strict; the natives have no incitement or desire to break them; the breeding places of shearwaters are usually all but inaccessible; the birds themselves are nocturnal and are never seen near the island or heard in daylight. All this happy combination of factors makes for the safety of the remnant of these birds, and there is an excellent chance of the cahow's persisting for many years to come.

With such an interesting history behind it, the cahow, which is found nowhere else in the world, should almost have a place on Bermuda's coat of arms, such as, Quarter: Ultra-marine, cahow argent rampant. Motto: *Habitator senectus resurrectus.*



The first oceanographic work of the Department of Tropical Research was performed aboard the Arcturus, *of 2,475 tons.*

(Below) Trawling at great depths was easy with the powerful booms and winches of the ship.



Résumé of the 1935 Expedition of the Department of Tropical Research

The Department of Tropical Research came of age in 1935 and sent out its twenty-first general expedition, the eighth to Bermuda. Four and a half months were spent in oceanographic work, with a personnel of six, the regular staff of the Department—Dr. Beebe, Mr. Tee-Van, Miss Hollister and Miss Crane—together with George Swanson, artist, and Vincent Palmer, field assistant. While our actual work was done at the Zoological Society's laboratory at New Nonsuch, yet as before, we were permitted by the courtesy of Dr. Conklin and Dr. Wheeler to make the Biological Station our living quarters, so our ultimate scientific results should be accredited to both institutions.

Funds for the expedition were generously provided by Mr. and Mrs. Frederick Ecker, Clark Williams, Childs Frick, William T. Dewart, Herbert Satterlee and Colonel Edwin M. Chance. We had our usual number of interested visitors this year, among whom were Kermit Roosevelt, Mr. and Mrs. Vincent Astor, Dr. W. Reid Blair, Governor and Mrs. Lehman, Mr. and Mrs. George Vanderbilt, Mr. and Mrs. Childs Frick, Admiral and Lady Best, Mr. and Mrs. E. T. Weir, Dr. and Mrs. Roy Chapman Andrews, Dr. Harlow Brooks, Dr. and Mrs. Harold Hays, Prince Obolenski, Dr. Lewellys Barker, Col. and Mrs. Edwin Chance and Mr. and Mrs. Henry Breckenridge.

The Gladisfen *was smaller, but it permitted trawling at a depth of* 1,200 *fathoms.*

(Below) The Skink *hardly compared with the* Arcturus *and* Gladisfen *in size, but it served for trawling at* 300 *fathoms.*

It was not possible to charter our old tug *Gladisfen* for deep trawling, yet we much desired young, luminous deep-sea fish to complete life histories and for comparison with shore fish.

It will be remembered that our first oceanographic work was undertaken on the *Arcturus,* a vessel of 2,475 tons and 282 feet in length. During the last few years in Bermuda the *Gladisfen* has answered every purpose, enabling us to trawl to a depth of 1,200 fathoms, although she is a tug of only 110 tons burden and measures 98 feet over all.

Our tiny *Skink,* which has done such excellent duty for five years, is a launch of a scant 3 tons, with a total length of 26 feet. Nevertheless, driven by necessity, we rigged on its aft deck a hand-winch with a half-mile of fine wire and a metre wheel, and with this almost absurdly diminutive outfit we actually drew half-metre nets a full 300 fathoms down. This third of a mile is well within the range of luminous deep-sea fish and other organisms.

There is probably no more difficult field in the world for collecting than the depths of the ocean. If a squall had arisen when we were far out from land we would have had to cut our wire and lose everything to keep from foundering. If the deep currents had increased in force or shifted their direction we would not have been able to pull in our net. But all went well and in the course of a few hauls we were able to secure fresh specimens of many abyssal larvae.

For example, Haul 1,538 was made five miles off Nonsuch, at a depth of 300 fathoms, or 1,800 feet. A half-metre net was used and was drawn for only an hour, yet it contained 1,680 creatures, including six species of luminous deep-sea fish—round-mouths, silver hatchets and lanternfish. There were nearly a hundred of the strange beings known as salpa or doliolum, which have just missed being pukka back-boned animals. More than twelve hundred crustaceans were caught in the net, some pink, others white and lavender. One had gold-banded, bronze, cylindrical eyes, and others came up out of eternal darkness to reflect the sun's rays with opalescent splendor. More than a thousand were copepods, which in variety and interest are the insects of the sea. Mollusks were represented by a slender, abyssal squid and many delicate flying snails. One hundred and seventy worms were brought up, bizarre in shape and with spun-glass swimming-bristles. There were 70 jellies and siphonophores, and almost as many beautiful one-celled creatures, called radiolarians, with shells of delicate and lovely structure, glowing with evanescent hues which vanished with death.

In the course of more than fifteen hundred nets drawn in this area, more than seventy species of deep-sea fish have been taken at or above the 300-fathom level.

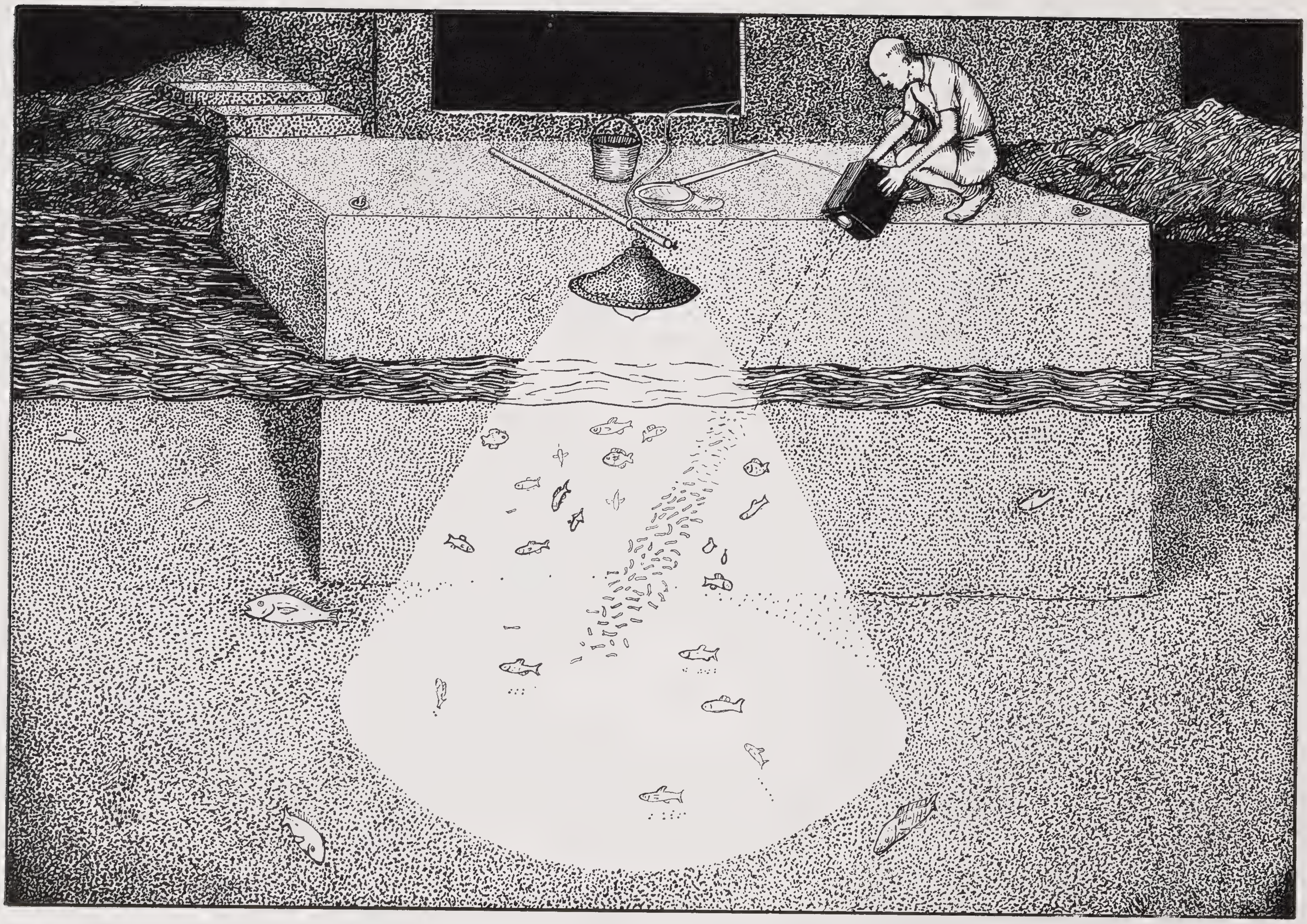
I offer these details chiefly to encourage owners of launches of reasonable size to carry on this work. We know so little about deep-sea life that the contents of a single net may contribute many valuable scientific specimens, bringing into the upper light and air the outposts of the strange dragon-like inhabitants of the deep sea. I would strongly advise, however, having the winch connected with the engine, and thus save the heart-breaking winding-in which was our portion.

SEVERAL years ago on Nonsuch Island, Dr. Newton Harvey and I experimented with ultra-violet light and fluoresced recently caught deep-sea fish and prawns. The stream of luminous liquid which, at times of danger, certain squids and prawns pour out into the blackness a mile below the sea, fluoresced strongly, as did the eyes, cheek lights and teeth of a number of deep-sea fish. Even the line of ten tiny tail lights of *Gastrostomus,* the great gulper eel, glowed under the ultra-violet rays.

My friendship with H. T. Strong of New York City, who has carried on most remarkable experiments with various light waves, resulted in his making for me an ultra-violet arc lamp which he brought to Bermuda. We found that its strength was so great that the tiny beam of invisible light would fluoresce willemite and other minerals a quarter of a mile away. I had insulated cable only of sufficient length to experiment from Nonsuch wharf, but we observed strong fluorescence in a suspended mineral near the bottom, ten feet below the surface.

As it turned out, I was unable during the summer to collect any large deep-sea fish, but in experimenting from the wharf several wholly unexpected results were obtained from the submarine projection of the ultra-violet beam.

On moonless nights, our 250-watt electric



Drawing by John and Helen Tee-Van

This sketch shows the method of employing the invisible rays of ultra-violet light to attract fish. Irresistibly impelled to enter its beam, they were held there helplessly as long as the light was on, arranged in a very evident segregation of species.

light with its tin reflector was always suspended a foot above the water, for the purpose of attracting any fish which might come within its area. There were the ordinary types of various species of small fry, anchovies, hog-mouths and pilchards, swimming about in mid-water, together with mullets, silversides and herring. A school of squid or a marauding barracuda were less commonly seen. At the surface, occasional baby flyingfish drifted past near patches of sargassum weed, with butterflyfish, triggers and half-beaks. Near the bottom, pink-and-white squirrelfish and gray snappers lay in wait for stray fry, and now and then a moray eel, octopus or giant crayfish crawled across the visible field.

One evening I shut off the electric light and switched on the ultra-violet, and to my astonishment the host of fry, scattered sparsely throughout the 50-foot circle of illumined water, all rushed into the eight-inch beam and remained there, becoming at the same time violently agitated. As we looked down from the wharf we saw the beam filled almost solidly with an incredible, wriggling mass of fish, almost touching each other. I switched lights back and forth and the same thing always happened. As soon as the electric light replaced the ultra-violet, the writhing cylinder of fish dissolved and the component hundreds of individuals swam about as before, quietly and isolated. Then when the black beam was turned on, again they rushed into its path. Furthermore, when I kept the ultra-violet going more than two minutes, there was apparent a very evident vertical distribution or segregation of species. The upper area, for a distance of about two feet beneath the surface, was a pure culture of the small, almost transparent larvae of green fry (*Jenkinsia lamprotaenia*), while the rest of the beam contained a mingling of the larger fish.

To confirm what seemed optically unbelievable, I made a scoop with the net under the electric light and caught two small fish. After 30 seconds of the ultra-violet I swept upward through the beam and secured more than four hundred individuals. These I placed in a large tin tub and again turning on the beam, this time diaphragmed down to a thin pencil, I found I could absolutely control the movements of the dense school of captured fish, drawing them from side to side and around and around the tub at will, as they helplessly followed the invisible but irresistibly compelling rays. The lethal power of the lamp was shown when I irradiated a sargassumfish in a small aquarium, and it was dead the following morning.

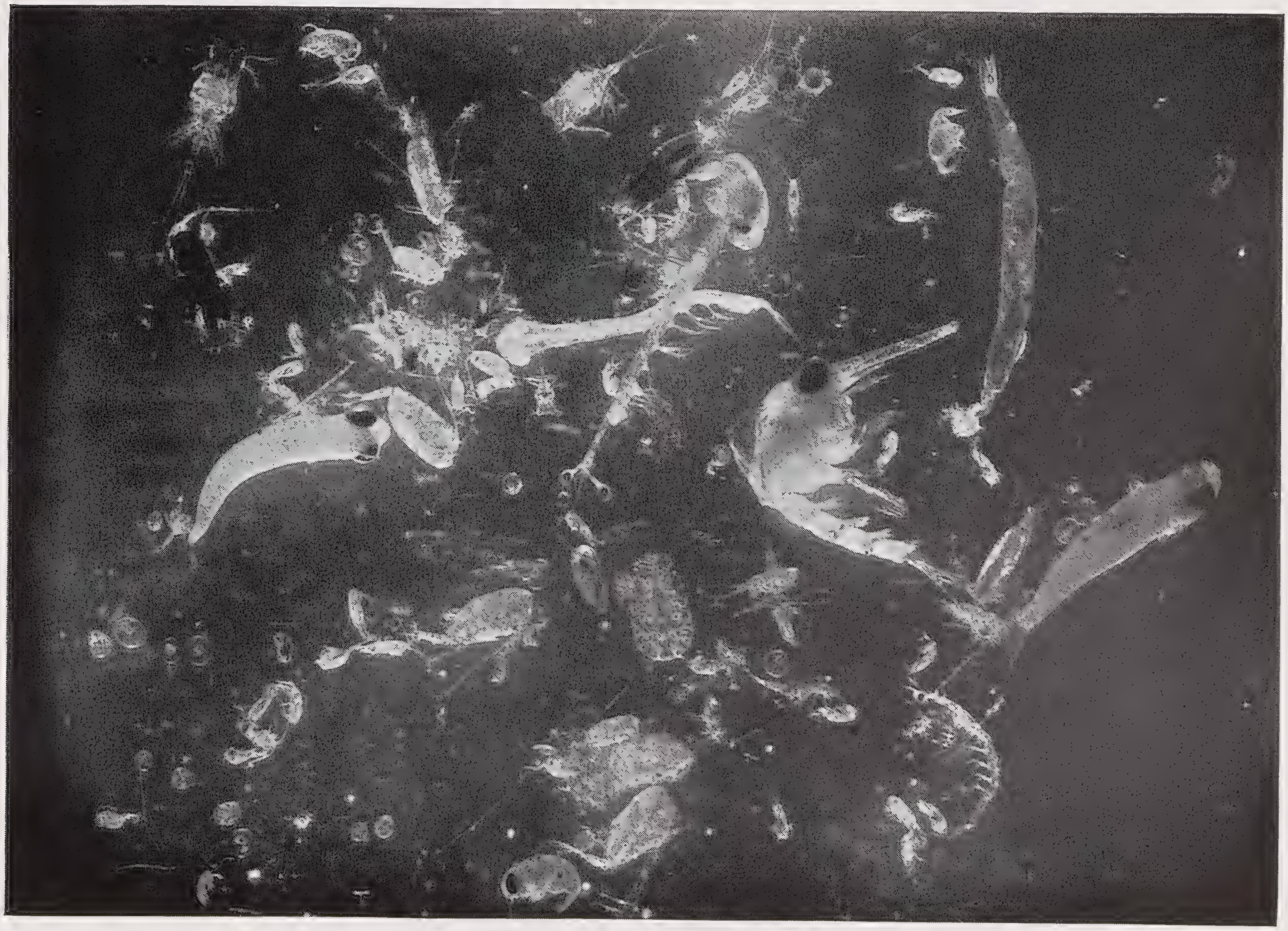
Pressure of other problems and the lack of large deep-sea fish prevented me from carrying on further experiments. These must be postponed until another season. Mr. Strong promises me a lamp next year with four times the penetrating power of the present one, and this I hope to put to practical use at night, well out at sea, in attracting rare sub-surface fish and other organisms. It may prove a valuable adjunct to collecting with a net.

The following activities may be mentioned, but they will be reported upon in detail in separate articles in the Bulletin and in Zoologica:

Mr. Tee-Van and I worked on a new motion picture film of the greatly enlarged head of a developing deep-sea eel, showing the growth and development of the various organs.

Miss Hollister, for the first time, succeeded in rearing the larval bonefish or ladyfish to its adult phase, and has almost completed her studies of the evolution of the tail bones of the more generalized shore fish. She has also raised sargassumfish, supplementing my studies on the egg-laying and larval development.

Miss Crane and I, with the help of my artist, Mr. Swanson, have completed the monographing of two additional families of deep-sea



This is a sample of the plankton brought up from a depth of 300 fathoms by nets operated from the little Skink *this year. Young lanternfish, luminous shrimps, arrow worms, copepods and abyssal amphipods may be seen.*

eels, which are already in type for publication in Zoologica. Minute analyses have also been made of many surface and sub-surface hauls, both as to vertebrates and invertebrates.

The rediscovery of the supposedly extinct Bermuda cahow added to the prestige of the Zoological Society's expedition, but perhaps the most interesting result of the summer's work was the intensive study of a game fish, the tuna, which has unexpectedly been discovered and exploited in the waters about Bermuda. Its food has provided a wholly new source of material knowledge of the fish which inhabit the zone of coral reefs, where no net or dredge can be used and hooks are almost useless.

Never out of mind, tied up with all our activities, is always the basic undertaking of our expeditions to these islands—a comprehensive ecological survey of the entire world of Bermuda fish, from the shallowest of tide pools down to the utttermost depths. Hundreds of facts are being recorded, studied and pigeonholed, all to fit ultimately into place, in as complete a monograph of life histories as human patience and intelligent concentration can make it.

It is gratifying to record the success of our last undertaking, "Half Mile Down," published under the aegis of the Zoological Society, which has been translated into Braille for the blind, and into French, German, Italian, Czech, Dutch, Swedish, Polish and Russian.

The laboratory of the Department of Tropical Research at New Nonsuch.

The contemplative man's recreation . . .

The Kankakee in the Old Days

Fifty Years Ago the Grand Marsh Had no Equal for Profusion of Fish and Wildfowl and Small Game

Dr. F. E. Ling

[*A lifelong resident of Hebron, Indiana, in the heart of the old Kankakee marsh region, Dr. Ling has drawn upon his memories of "the good old days" of half a century ago for the following article about the marsh as it used to be—and as it may be again, if the Indiana State Department of Conservation plan for restoration is effected.*—Editor.]

My first acquaintance with the Old Kankakee was about fifty years ago when I was a youngster six or seven years old. My father, who owned a store here at that time, enjoyed hunting and fishing and took me with him. We would leave home early Sunday morning and walk about four miles to the boat landing at the edge of the marsh, aiming to get there about daybreak and out to the river by sun-up.

I sat in the stern of the boat, flat on the bottom, and by using a short paddle tried to keep the boat about a certain distance from the bank as we floated downstream. Using an eighteen- to twenty-two-foot cane or bamboo pole and about the same length of line with a Skinner or Chapman spoon, Father would throw out toward the bank under the overhanging branches of trees or along the logs, grass or moss, and draw the spoon around in front of the boat. When he hooked a large pickerel, wall-eye, bass or dogfish (grinnel) the fun was on. As I grew older I learned to stand up in a boat and push or fish. Later he built me a boat of my own, and then a chum and I spent most of the summer days on the river.

We never put "if" in the fish-catching game. It was a mighty rare occasion that we didn't get all the fish we wanted. We seldom looked for bait until we got to the river. You could catch frogs, minnows, crayfish or hoppers there. We caught our minnows by hooking the knob end of the push paddle into the moss and pulling it out on the bank and picking the minnows out of the moss, or by running the boat along about five or six feet from the bank where there was moss, stepping on the edge of the boat and holding it as low as we could without dipping in any water. Then we would hit the moss with the paddle and the minnows in their fright and haste to get away would jump into the boat.

The photographs illustrating this article were taken by or for Dr. Ling in the Kankakee marsh many years ago.

A shallow boat and a push-paddle were necessary for penetrating the marsh in the old days. In the bayous such as this one there was food and cover for countless wild waterfowl and the still waters teemed with fish of many kinds.

This will give you some idea of why the Kankakee had fish in it. It had ideal natural spawning and rearing conditions for fish. One season the river was alive with small pickerel weighing about a pound and a half. A boy friend and I caught eighty-seven in about an hour. He caught thirteen fish in thirteen straight casts of about thirty feet. On the fourteenth cast he hooked a fish and lost it. He threw his steel casting rod down in the boat and said, "Damned if this is fishing. It's slaughter." Then he lit up his pipe and enjoyed himself.

You could catch these fish anywhere for miles along the river. Where they came from no one knew. One other year we had a similar condition, but not so many fish, but larger ones ranging from four to five pounds. They must have had the natural feed all eaten, for they would hit anything that moved. Father and I caught fourteen in less than a mile of river. On one cast, when one hit his spoon, it jerked the end of the long cane pole into the water and another fish struck the end of the pole, the splash having attracted it. These years were the exceptions, not the rule, but we always had lots of fish. Many times when we were kids have the kid brother and I dragged a string of fish on a dog chain which was too heavy for us to carry, from the boat landing to where the old cracky wagon and pony were left on high ground. Many and many a time have I looked over the edge of the boat and seen a school of bass or wall-eye in ten feet of water. The water was very clear and there was no pollution before dredging. It is not so clear since dredging, but has no pollution even now.

In the spring of the year, after the ice had gone out and we had had our first thunder storm, the old fishermen would go dogfish spearing. They would anchor their boats on the shallow side of the river bend on a sand bar where the water was from four to eight feet deep and where the current would carry the fish over the sand. The fish would come lazily floating down, resembling sticks of sunken wood. They would come drifting along from singles to droves of six or eight and the fishermen would spear boatloads of these fish and salt them down.

In a little shed on the edge of the marsh Dr. Ling's father kept his boat and there they would walk before sun-up on Sunday mornings to be out on the river by dawn.

The dogfish run was on every year as far back as any of the old timers could remember, and the Indians before them enjoyed the same sport. When they dredged the river the run stopped and there are very few in the ditch now. The dogfish spearing started the season's fishing and it wound up with wall-eye fishing late in the fall when slush ice was running in the river. Live minnows were used for bait at this time of the year and the fishing was done just on the lower side of a drift, the drift of logs protecting you from the floating ice. We had several varieties of fish: dog, cat, bullheads, carp, buffalo, pickerel, croppies, bluegills, perch, suckers, sunfish, black bass, wall-eyes and some eels. Many a day have we filled a stringer with a catch of different varieties.

The swamp and marsh ranged from one-half to five miles wide and was about one hundred miles long. This expanse of territory with its sloughs, bayous, ponds, natural feed and hollow trees made it a wildlife haven. Very many kinds of trees, shrubs, flowers, grasses and aquatic plants grew in this area. Many of the bayous and pond holes in the timber and marsh were a white carpet of water lillies and the banks of the bayous and ponds were lined with marsh hollyhocks. In our upland gardens they are called hibiscus. In the spring the islands were one mass of flowers—spring beauties, Dutchman's breeches and violets. Later the May apple covered large areas with its umbrella foliage and the Indian turnip with its green calla lily bloom was seen everywhere. Squirrels, groundhogs, chipmunks, flying squirrels and many varieties of birds were numerous.

The greatest thrill of a squirrel hunt was that the whole area seemed to be alive with wild

Bringing home a boatload of ducks was the rule rather than the exception in the Kankakee marsh in the old days and this load was "just an everyday occurrence."

The swamp provided the natives of the region with all the wood they needed for fences and firewood — free for the hauling.

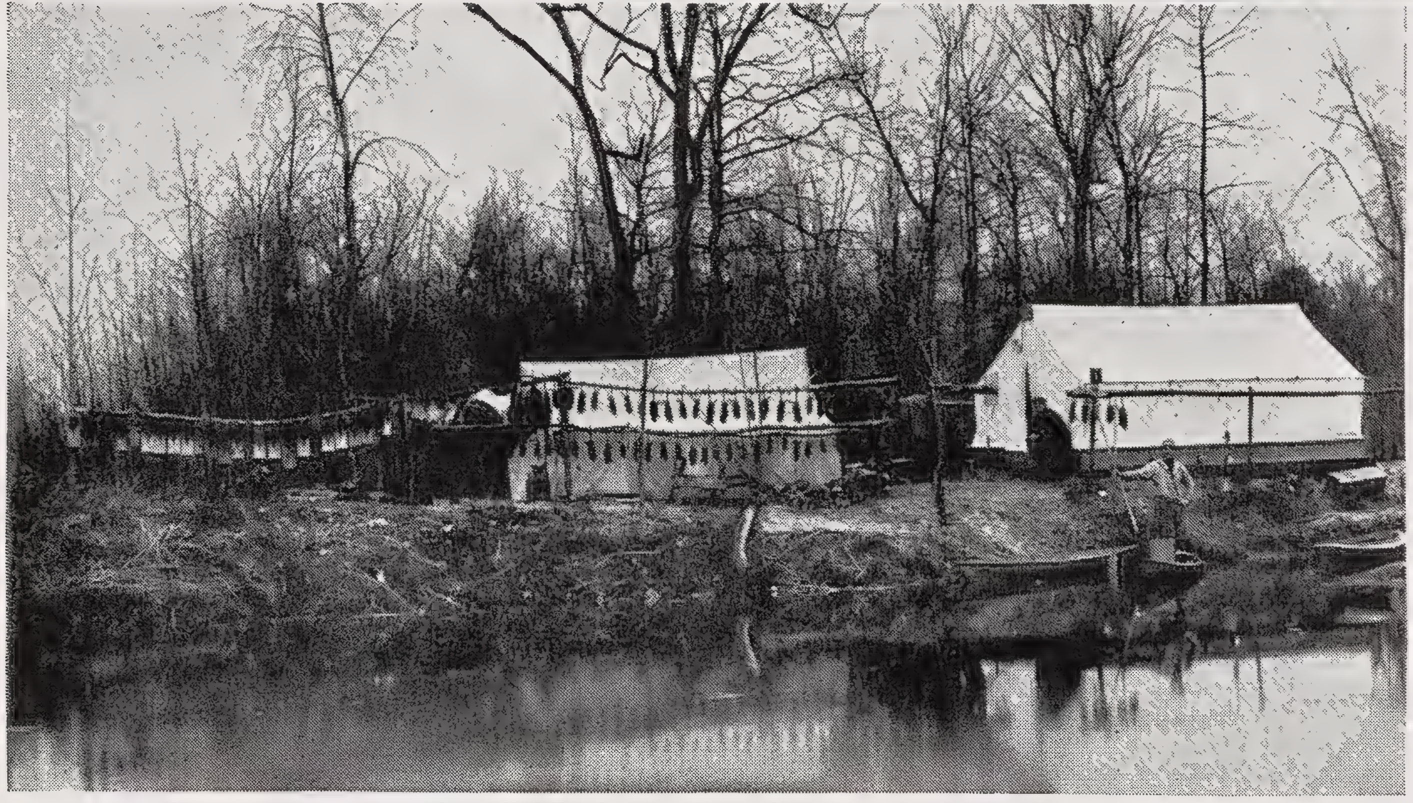
An old wooden bridge over the Kankakee near Hebron. Sewer pipes and a mud hole occupy this point now.

creatures. Many a time have I sat at the base of a big beech tree by the hour watching the wild life and not firing a shot. This area of from ten to fifteen acres seemed to be completely roofed over by the spreading tops and branches of the big beeches. I haven't words to describe what took place in this apartment building of Mother Nature's. When the squirrels were working on the beech nuts, the dropping of shells and nuts sounded like heavy rain. A hunter killed a mixed bag of 103 black, gray and fox squirrels in this area in one day.

The trees on the islands were beech, white oak, burr oak, red oak, black oak, hickory, pepperage, butternut, black walnut, white ash, black ash, sycamore, soft maple, sassafras, wild cherry and paw-paw. On the low lands there were pin oak, burr oak, black oak, red birch, elm, black ash, white ash, sycamore, cottonwood, soft maple, quaking aspen and willow. Acres of witch hazel, blackberries, raspberries, blueberries, huckleberries and wild strawberries were found on the islands and around the edge of the marsh. Large areas of pucker brush and devil pins were found in the lower areas around the bayous and ponds. In the marsh wild rice, smart weed, Spanish needle, celery, duck potato and many other grasses and weed seeds furnished natural feed for geese, ducks, birds and animals. In the timber they found acorns, wild rice, smartweed seed, pucker brush balls and other aquatic plants and roots.

During the migration season ducks, geese, brant and cranes were on the Kankakee area by the thousands and there were all varieties, from canvas backs to fish ducks. Canada geese fed on the prairie in the wheat and corn fields and rested on the marsh by the thousands. The tales some of the old timers tell are almost unbelievable. Sandhill cranes were plentiful but not nearly as numerous as geese. Many swans were seen on the marshes. Later in the season hundreds of herons, blue and white, nested here. At different places in the swamp the cranes

A duck hunter's camp in the old marsh, wood and provisions ready for the ice to leave the river.



Fur-hunters claimed "trappers' rights" over sections of the marsh and took thousands of pelts.

had what we called "crane towns." Hundreds of them would meet in one locality in the cottonwood trees. Many times I have seen as many as four or five nests in one tree. The largest town, the one we called "lower crane town," was estimated to have 1,000 cranes and, believe me, there was some music when the young were in the nests! Thousands of jack snipe, sand snipe, plover and other shore birds lined the marsh shores and upland ponds.

The principal fur bearing animals were muskrat, mink, otter, skunk, racoon, fox and beaver in early days, and occasionally a lynx and bobcat. In 1912 on the Degolia marsh, a tract of from 1,000 to 1,200 acres, from November 1 to December 20, the date when the marsh froze over, two trappers camping together caught 7,634 muskrats. During a period of a few days after the freeze-up they speared 1,300 more in their houses on the same grounds. This was a good rat marsh but not any exception to many others along the Kankakee. In the winter when the swamp was frozen over, fur was hunted on the ice. The party generally consisted of two men and three or four dogs. Two men could work to better advantage than one in climbing trees and throwing out the 'coon and chopping mink out of their dens. It was not uncommon for a pair of hunters to catch from $500 to $1,000 worth of fur during the ice hunting season. This was a free-for-all, the old trappers holding their trapping grounds by what they called trappers' rights, but the rights ceased when the swamp froze up.

The swamp had many hollow trees and many of these held swarms of bees. I have known one man to find sixty-five bee trees in one fall. Twenty to thirty-five bee trees were just an ordinary cutting. I have seen them produce honey in amounts all the way from the size of a walnut to two washtubs full. You never could tell from the looks of a tree what you were going to find. Sometimes when you had washtubs and boilers ready, you needed a hot biscuit, and other times

In the spring when the ice was going out, the dogfish spearing season began on the Kankakee River.

Every bend in the river opened a new vista of loveliness and promised delights for the fisherman.

you had to leave part of the honey or make another trip for it. In the winter many of the natives for miles each side of the swamp cut the timber for fence rails and wood. In the late afternoon and evening the roads leading from the swamp would be a procession of loads of wood. Timber, fur, fish, birds, animals and game weren't all there was to the Kankakee. It was a beautiful, clear, winding river with its tree-covered banks, its large drifts of logs, wild hollyhock banks and lily-covered bayous.

In the fall it presented a beautiful scene with the foliage flaunting all the autumn hues, ranging from the deep green of the pin oak to the naked branches of the ash, and every bend offering a different picture. The time I liked most to be in the swamp was when the leaves were all off, the wind blowing a gale, lashing the tops and limbs of the trees, a gray, drab, fast-moving clouded sky, and the air full of ducks trying to find a shelter from the coming storm. This kind of a scene meant you were going to have a hard push home in a storm, but it was worth it.

The Kankakee was one of the greatest wood duck nesting grounds in the U. S. A. Hundreds of pairs nested yearly in its hollow trees and stumps along the river, bayous and ponds. During the summer months, before the young were able to fly any distance, the broods were scattered all over the river and swamp wherever there was water and feed. You would see many broods of them in the summer while fishing. In August when the young were able to fly they began to congregate in certain roosting places. For about two hours before dark in certain areas of bayous, ponds or sloughs that had lots of old logs, floating flag roots and pucker brush, the air was full of wood ducks, from singles to flocks of fifty coming to roost. It was not uncommon to see 500 wood ducks in the air at one time, in these areas. They fed all over the swamp and sloughs, mostly on acorns from the thousands of trees in the swamp, but they roosted in certain suitable areas as soon as the young were able to fly well. The destruction of such good nesting and rearing areas has had much to do with the scarcity of wood ducks. I believe that drainage has done more to create our scarcity of ducks here than all other causes combined. Thousands of ducks and many geese nested here before the area was drained.

One late fall afternoon when no birds but the red headed woodpecker were stirring, a slight northwest breeze had just started to blow as I was leisurely pushing my boat up the river, aiming to get to the boat landing at dusk, having agreed to meet my hunting partner there at that time. I was about a mile from the landing when I heard someone call to me to hurry up and get to the landing as soon as I could. I looked around and saw my partner pushing as fast as he could and motioning for me to hurry on. At that time I also saw several flocks of ducks coming from the southeast, going northwest, and bent on going on about their business and paying no attention to a call. He called to me again to hurry on to the landing and waste no time. I knew he had some good reason for wanting me to hurry so I put on all steam ahead, and when I turned in at the ditch that led to the landing and boathouse I slowed down and waited for him to catch up.

By this time the air was full of ducks, all going northwest, but they paid no attention to the call, not one of them. When he ran his boat alongside of mine he said, "Hurry up, let's get to the landing and try to kill some of those ducks." We grabbed our guns, hunting coats and shells and ran about ten rods to the top of the ridge, which was maybe forty-five feet above the water. My partner said the ducks were changing marshes. They had been up east in the south marsh and were going to the north marsh. These marshes were so called from their position to the river. He said that tomorrow we could go back in the territory we had been in today and found no ducks, and find plenty of them, for they were moving in.

When we got to the top of the ridge his instructions were, when a flock came over us within range, to pick out a certain bird, follow it until it was directly overhead, jump in ahead of it, shoot one shot only, and we would kill some ducks. Did he know his duck shooting? I'll say he did!

We picked up a mixed bag of sixty-eight ducks in about an hour out of this flight and they were flying just as thick when we quit shooting as they were when we began. Then the weather man decided we had enough and sent a northwest wind with heavy, thick, dark clouds, which made it rather uncertain shooting. Rather than cripple and lose the ducks we unloaded the guns.

My partner was one of the old time real hunters. He studied and understood the habits of birds and animals. He wanted to know why they did this, and why they did that, and he figured out many of the whys. It was the rule rather than the exception for him to kill two ducks at one shot on the wing when coming in to decoys. He said that a pair or more of ducks very seldom came in to decoys without two of them crossing within gun range.

Before the drainage of the Kankakee we had hundreds of prairie chickens and many partridges. Now we haven't any. Their natural home has been ruined. In destroying the native marsh grass they destroyed the home for the chicken, it being their nesting place. It seems that certain conditions and feeds are essential for the nesting and rearing of wild birds and animals. Nature provided this, but the progressive, intelligent white man in his march of progress has failed to consider this and consequently unless there is a change of policy our wild life must go in spite of its efforts to continue with us.

Some spots of this drained land are still producing fair crops, but the part we wish to restore is practically worthless and could be made a wildlife haven by reclaiming it according to the State Conservation Department's plan. Not only would it be a wildlife haven, but a source of much revenue. Its location is ideal for recreation, having several million people within a hundred mile radius. I hope to see the circle completed—from marsh to wilderness and back to the original wonderful marsh again.

And then the dredges came . . .

They Say the Kankakee Is Coming Back

Indiana Has a Practical Plan for Restoring a Hundred Thousand Acres of Famous Marshland to a Wildlife Paradise

William Bridges

THERE never was anything quite like the old Kankakee marsh in northwestern Indiana—the Grand Marsh they called it in its great days sixty years ago. Never anything else and never will be.

The superabundance of its feathered game and fur and fish was next to unbelievable. I have heard old men recall the mighty rush of wings as clouds of ducks rose before the guns of the market hunters, listened to their description of creaking wagons hauling hundred-pound bales of mink and otter and 'coon and muskrat skins into the railroad towns, and pictured through their memory the flatbottom boats that sometimes sank under loads of bass and perch and pickerel.

As a child I remember the soft spring nights and the frosty October evenings when we strained to follow the faint music of migrating geese, wondering the while if they would again nest in the Kankakee and find food there another autumn.

Last summer I went back to the Kankakee. I had never actually visited that section of my native State before, but the Kankakee—the Grand Marsh—was as real to me as the memory of things seen. I knew in general what had happened there in the last thirty or forty years. Land promotion schemes had flourished as it was ditched, drained and turned over to agriculture; railroads into Chicago crisscrossed it; the prolific wildlife had vanished. The old Kankakee marsh was drained and ploughed out of existence, but there was talk of its restoration. Somebody said that the Indiana Department of Conservation had developed a practical plan for returning a part of it to its original condition. I wanted to see for myself if it could be true, if there was any possibility of the Kankakee coming back.

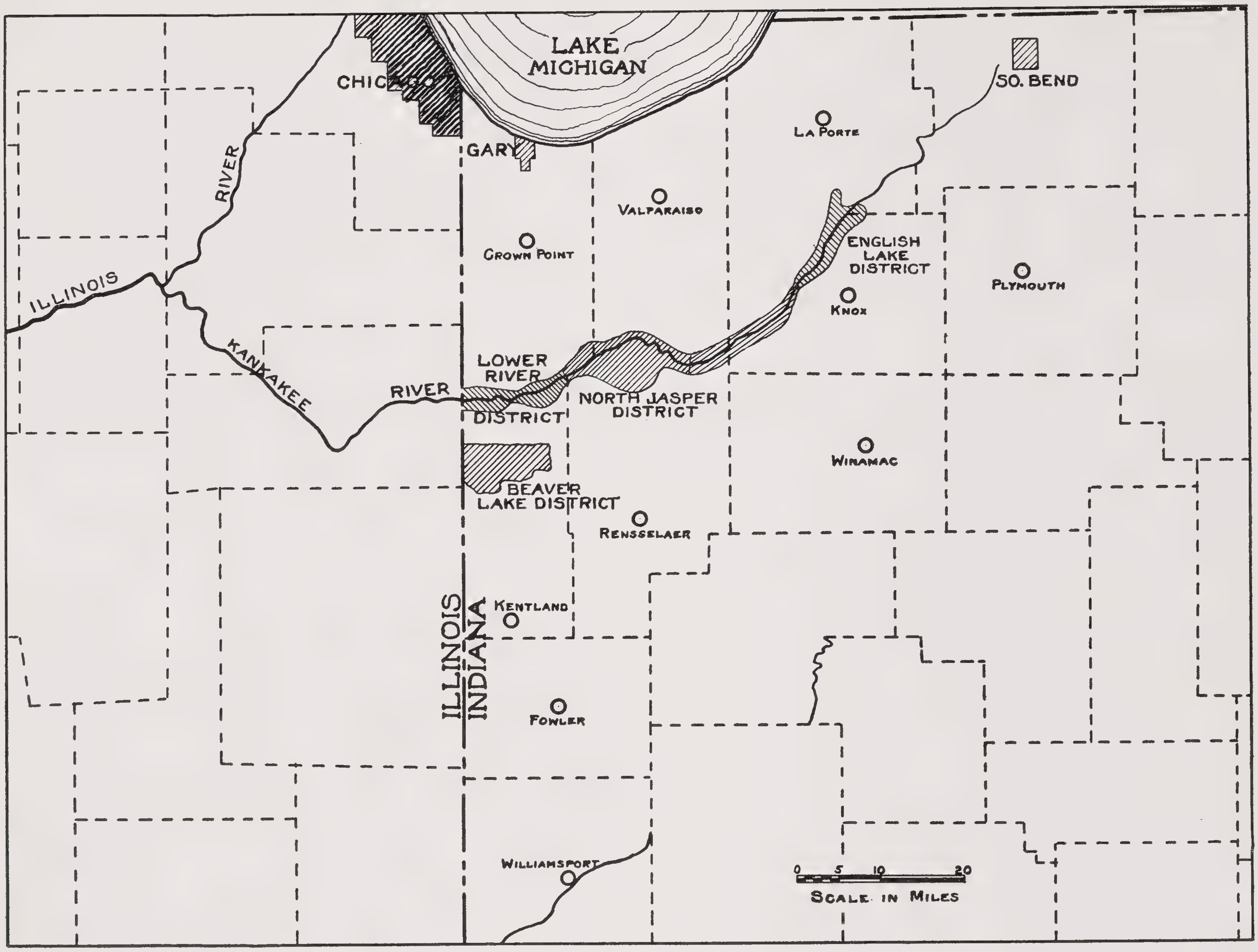
Whether it is actually coming back, I don't know. That seems to be a matter that the Federal authorities at Washington will determine—the Bureau of Biological Survey is said to be interested. But after tramping and wading and driving through seventy-five miles of the old marsh country I am convinced that the Kankakee can come back and again be the greatest wildlife refuge in North America.

Potentially the old Grand Marsh is still there, patiently awaiting the day of restoration. Sooner or later Nature is going to win, aided by ditch assessments and delinquent taxes. Then a thousand weed-grown ditches are going to silt up permanently. Spring thaws and the rains again will flood the lowlands that were never intended for anything but a wildlife paradise.

I saw a thousand acres of the old marsh living again. It was a private restoration undertaken by one large landowner who had grasped the vision and led the way in showing what can and eventually will be done. Old-timers in the Kankakee told me that here the waters again are teeming with fish, that sprouting sedge and wild rice again draw the wild ducks. More important, from an engineering standpoint, the Cameron development stays flooded the year around without affecting the drainage of the higher land that has been reclaimed successfully for agriculture.

When LaSalle discovered the Kankakee in 1679 at its source near South Bend, Indiana, it was perfectly described by its Indian name: "Slow river flowing through a wide marsh." For a hundred and fifty miles across the northwestern corner of Indiana it turned and twisted before it joined the Des Plaines River, becoming the Illinois River and one of the tributaries of the Mississippi.

The illustrations accompanying this article were furnished by the Indiana State Department of Conservation.



The Kankakee marsh region. Shaded areas are proposed for restoration.

The "wide marsh" that the Indians knew bordered the uncertain banks of the Kankakee and extended back from one to fourteen miles. There were really two sections of the marsh: the "lower marsh" or Grand Marsh of about 400,000 acres which remained flooded throughout the year, and the "upper marsh" of some 600,000 acres that was usually but not permanently flooded. Together, a million acres of fish and wildlife paradise.

Hunters and trappers came in the footsteps of LaSalle and his voyageurs. For a hundred and fifty years they did their best to exhaust the inexhaustible reservoir of fur. Market hunters poled their way into the swamp with barrels of gunpowder and shot, shipping trainloads of wild ducks and geese into Chicago. The advancing tide of pioneer settlement reached the Kankakee valley and the timber was cleared from the higher ground, but until about 1860 the lower and upper marshes were still untouched and for a long time after that date the inroads of drainage and agriculture were gradual.

The great days of hunting in the Kankakee were roughly between 1850 and 1890 when sportsmen's clubs sprang up everywhere in the Grand Marsh—the Alpine, the Marion, the Prairie, the Valley, the Diana, the Wallace and so on. The Wallace, incidentally, was named for General Lew Wallace who wrote most of "Ben Hur" on his houseboat there. The wreckage of the boat still can be seen against the crumbling bank of the old river bed at Baum's Bridge.

English Lake, Thayer, Wilder's, Baum's Bridge were some of the great names in those days. The Kankakee's fame was international and hunting parties of the English nobility used to shoot at Cumberland Lodge near the Illinois line.

But agriculture was creeping in. As early as

1873 they began cutting drainage ditches through the Beaver Lake district and as the higher and naturally drained land on the outer fringe of the valley was preempted, the rich muck of the lowlands attracted speculators.

At first the drainage ditches were turned into the tortuous old river channel but the runoff was not rapid enough. It soon became apparent that the channel itself would have to be straightened and deepened to secure faster drainage. Finally a new seven-mile channel was cut for the river, thereby draining about eight thousand acres.

What happened was about what might be expected. More water flooded down from the head of the river and made flood conditions worse in the lowlands. Speculators saw the possibilities of a straightened channel that would drain the entire valley and they pushed it through. A State drainage law was passed to speed up the wreckage of the old marsh and in the space of a few years 87.8 miles of arrow-straight new channel had been cut through the valley and narrow drainage ditches dug to carry the marsh water to it. When they finished the last of these lateral ditches at the Indiana-Illinois State line in 1917, the project had cost a million and a quarter dollars and the real costs were just starting.

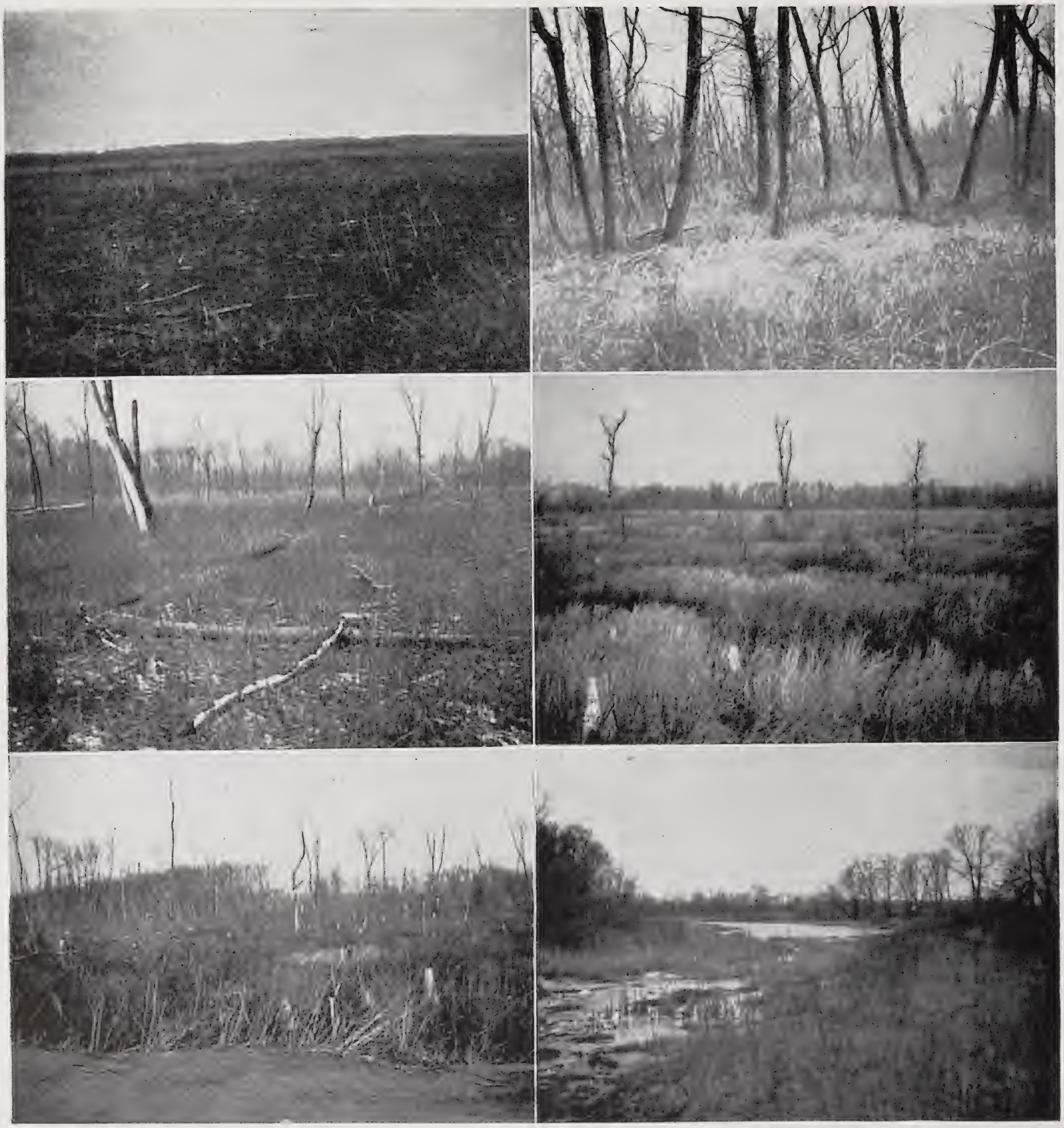
It was advertised by the promoters as "The richest farmland in the world" and excursion trains were run into the Kankakee country from all over the Middle West. The intricate system of drainage ditches was to avert a return of the floodwaters—and they did as long as the ditches were new and clean. But the loose, sandy soil washed easily and the drainage ditches began to fill up along with the new river channel. Dredging assessments piled up and in some sections crops would not thrive.

Today thousands of acres of the old Grand Marsh have been abandoned and I traveled for mile after mile over sandy trails in a wilderness of weeds and scrubby trees, occasionally crossing a choked-up ditch with its pool of stagnant water. Of course there are other thousands of acres of the former marsh under cultivation and producing profitable crops, just as fine an agricultural section as one could desire, but this area is not affected by the restoration plans.

There are about three-fourths of the former Grand Marsh which are dry, high and really profitable for agriculture since reclamation but it is with the remaining, definitely submarginal, acres that the Department of Conservation and the Bureau of Biological Survey are concerned.

Department of Conservation engineers made a preliminary examination of the Kankakee Valley in the fall of 1933 and went back in December of that year to start on a topographical survey of the area from the Indiana-Illinois line up the river to the English Lake district, covering a strip about ten miles wide and fifty miles long. They came out of it well informed as to the extent and value of the submarginal land, the location of areas that might be re-

Drainage ditches fill up with silt and weeds and have constantly to be re-dredged to keep the water flowing.



This land is all but useless for agricultural purposes and it is proposed for restoration to marshland. At the top: the English Lake district. Center and lower left: the Jasper County area. Lower right: a section of the old river channel.

stored without affecting the drainage of higher areas and with suggestions for economical restoration.

This survey, I was told, was almost diametrically opposed to the surveys which had been made in previous years, so far as the protection of agricultural interests was concerned. Restoration heretofore was considered more from a standpoint of restoring the river to something like its original condition, with the resulting marsh along its entire course. The idea presented in the 1934 report was for the restoration of certain favorable areas without affecting the river itself. Such a plan naturally does not affect the drainage of the Kankakee valley as a whole and makes certain the adequate protection of the drainage for bordering agricultural lands. The restoration methods proposed in this survey report, I learned, have been approved by a nationally-recognized authority on drainage who agrees to the practical value of the plan and the non-interference with existing drainage from the agricultural areas.

Indiana conservationists are pinning their hopes upon the Federal government for this partial restoration program, feeling that what might have been an impossible task for the State is really a modest one under the national policy for the acquisition of submarginal lands. They realize that the land prices might be higher than are customarily paid for wildlife restoration, because of the location of the areas, but point out that this same location is one of the factors making it more desirable.

The areas proposed for restoration are situated between the existing duck flights along the Illinois River and Lake St. Clair. There is no doubt that if the partial restoration is effected, the duck flight would come to this region in increasing numbers. The major reason, however, for favorable consideration, is its accessibility (it would be within an hour's drive for ten million people) and the large number of people who could see and become familiar with the activities of the Bureau of Biological Survey. To me it seems that the plan is good not only from a practical standpoint but would be of value in selling the Biological Survey's program generally.

The report of the engineers after the 1934 survey recommended the acquisition of approximately 100,000 acres, or one-fourth of the old Grand Marsh. This was roughly divided into four areas: 1. The lower river valley extending from the Indiana-Illinois line; 2. The Beaver Lake area which was not originally a part of the Kankakee Valley but was the feeding ground of many migratory birds and inhabited by fur-bearing animals; 3. The Jasper County area; 4. The English Lake district.

During my trip we visited each of these areas and it seemed that the Beaver Lake and Jasper County areas were entitled to first consideration, an opinion in which the engineers concurred.

The Beaver Lake area proposed for restora-

The Beaver Lake basin was the first to be drained and can easily be restored. This view from the top of "Bogus Island" shows part of the 36,000 acres that once were the favorite haunt of wild ducks and fur-bearing animals.

tion would include about 36,000 acres, roughly bordered by the State line and three State highways (10, 55 and 14). Most of this area is flat, surrounded by ridges and higher ground which made it a natural reservoir, varying from marsh near the rim to a shallow lake in the center. In the center is an island, rising forty to fifty feet above the surrounding plain, and known locally as "Bogus Island." It was the retreat of a gang of desperadoes in the early days, the surrounding marsh and lake making pursuit difficult if not impossible. I stood on the island in the midst of a sea of goldenrod and purple loosestrife that stretched for miles on every hand, seemingly as far from civilization as LaSalle when he pushed into the wilderness more than two centuries before.

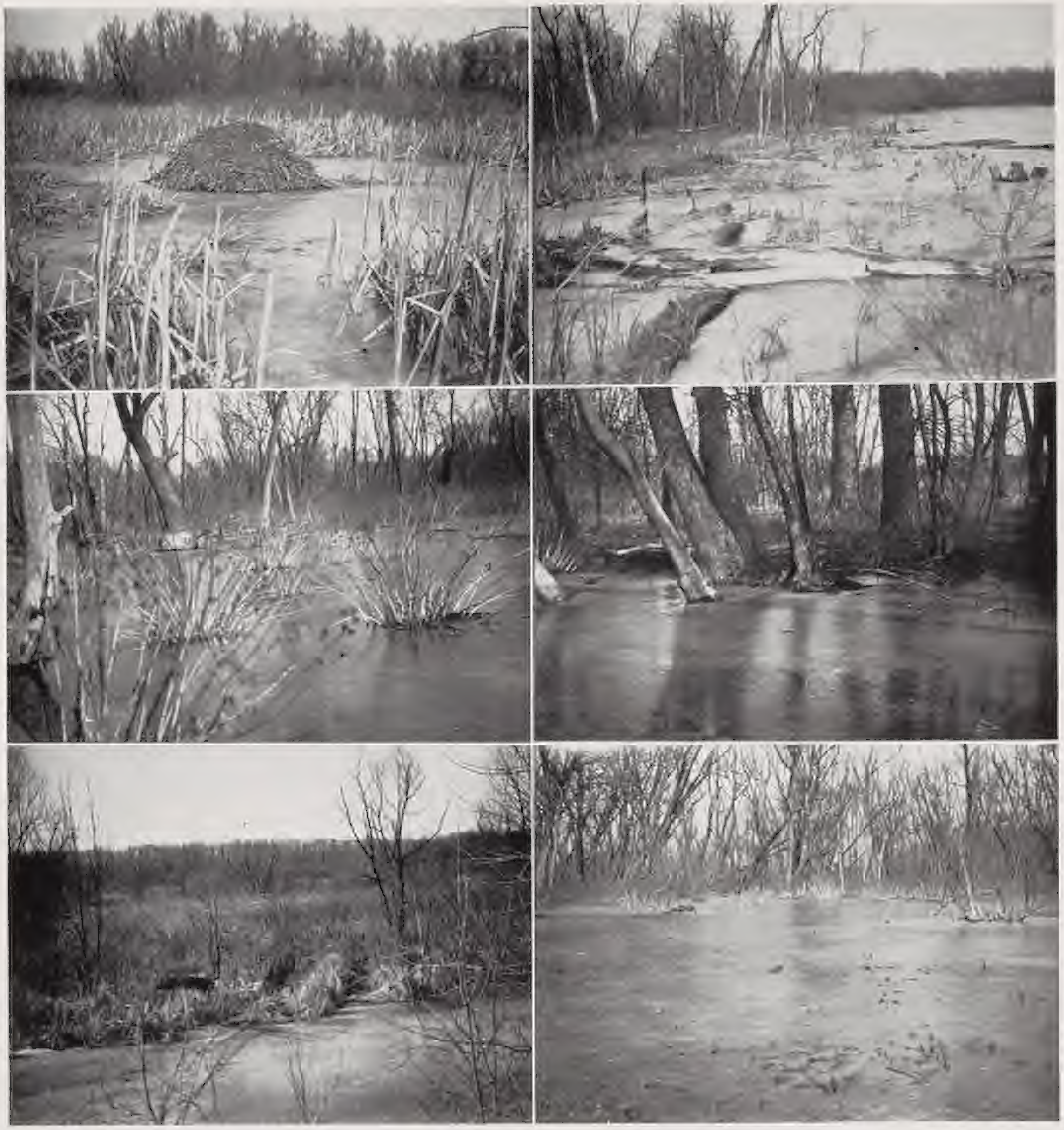
Because it was slightly higher than the rest, this basin was one of the first marsh areas drained, a channel being cut through the northern ridge to empty into the Kankakee. The water level of this area is close to the surface even in the drier months, but the land is generally poor and subject to erosion by wind when the native grasses are destroyed. Being practically a drainage district in itself, this area would require the least construction of any to effect restoration to natural conditions.

The Jasper County area was most attractive from the standpoint of the conservationist, since the Cameron development is an index to what the restoration would accomplish within a few years. This proposed area extends along the south side of the Kankakee, east and west from the point where the river forms its most northern apex and south approximately to the towns of Stoutsburg and Kersey. It would include some thirty to forty thousand acres.

A considerable portion of the land in this area is not good, much of it remaining in a semi-wooded condition through which forest fires have raged. There are scattered sections of wooded sand ridges and islands which could be planted with oak, the acorns again forming an important food supply for the waterfowl and wildlife that would be attracted.

The other areas would include a section bordering the lower reaches of the Kankakee, north of the Beaver Lake section, and the English Lake district which would be an amplification of the present 2,300-acre Kankakee game preserve. Development of these areas probably

This area in northern Jasper County is proposed for restoration to its original marsh condition. Sand ridges sparsely dotted with trees are the principal feature of the landscape and the lower ground is useless for agriculture.



Nature has reclaimed her own in the thousand-acre "Cameron development" in the heart of the former Grand Marsh. By tapping the Kankakee River and reflooding submarginal land, the original marsh has been restored in less than ten years.

will not take place for a good many years.

Here, then, is the situation that I found with regard to the restoration of the Kankakee:

The Grand Marsh is still there, potentially one of the greatest wildlife refuges that can be reestablished. Survey notes, maps and photographs complete to the last engineering detail have been placed in the hands of sympathetic Federal agencies for consideration. Two restored areas are there, pointing the way to what can be done, and the Indiana officials with a State-wide conservation organization of nearly a hundred thousand members are ready to cooperate in any feasible program.

I spoke of two restored areas; one of these is the Cameron area and the second is on the Jasper-Pulaski State Game Preserve. The late William Cameron of Chicago pointed the way toward restoration of the Grand Marsh eight years ago. He had a thousand acres of bottom land along the old river bed; wild, rough, covered with scrub timber and unfit for anything but grazing. Deciding to turn this unproductive land back into marsh, he tapped the river above his property and let the water spread over the land, the supply ditch being continued to the river at the lower end.

We tramped over a part of this marsh. It is a tangle of fallen timber and marsh grasses. The ducks are coming back—they say the number of migratory birds has doubled each year for the past four years—muskrats are building villages and the water is teeming with fish. And not an acre of ground outside his own property has been adversely affected by the transformation.

Over at the Jasper-Pulaski State Game Preserve they showed me several hundred acres of restored marsh, where dozens of species of waterfowl find food and protection throughout the year. Here, too, the ducks are coming in increasing numbers to nest in the spring and feed in the fall.

I was convinced that the restoration is practical—that sometime in the future the Grand Marsh can be more than a myth—and that, when the restoration takes place, other generations of children on soft spring nights and frosty October evenings can strain to follow the faint music of migrating geese, knowing that they will nest at the Kankakee in the spring and find food there another autumn.

Slow-moving water diverted from the Kankakee River has turned this formerly waste land into a breeding place for wild waterfowl. The number of migratory birds has doubled each of the past four years in the Cameron section of the old marsh.

Collecting Bats in Trinidad

Four Specimens of *Vampyrus spectrum* Are Exhibited for the First Time

Raymond L. Ditmars

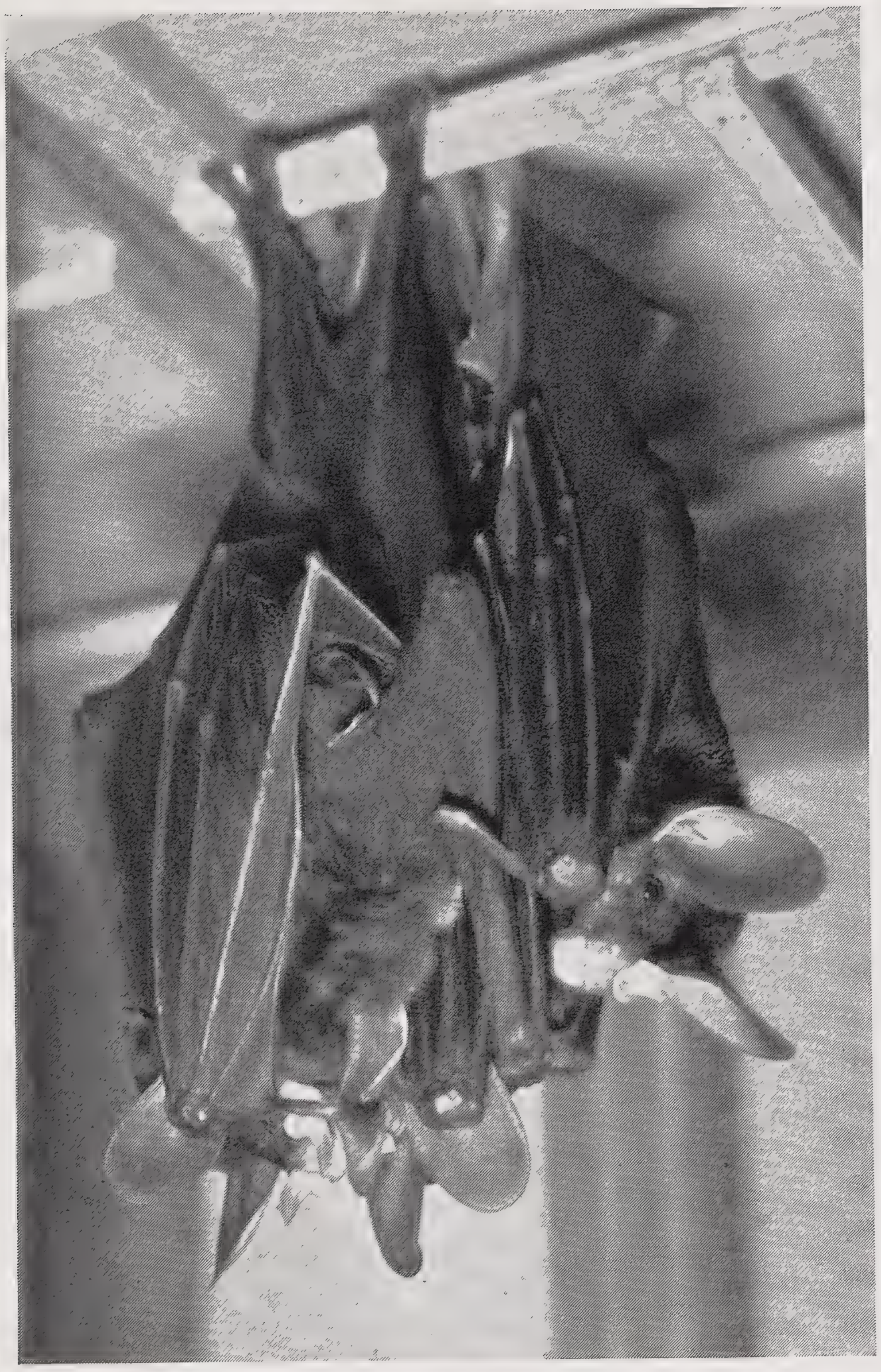
IT is always stimulating to realize that interesting discoveries may lie ahead of one, and thrilling when results come up to expectations. Such were the conditions that routed my annual tropical trip to Trinidad this year. One of the results accomplished is the exhibition at the Zoological Park of the giant bat, *Vampyrus spectrum,* by far the largest bat of the American tropics. This is the first time that living examples have ever been brought to a zoological institution.

The writer left New York on September 19 on the S. S. *Nerissa* of the Furness Withy Line. This vessel runs direct to St. Thomas, the most northerly of the Virgin Islands, thence touches at all of the islands of importance along the chain of the West Indies. From Trinidad the route is to Georgetown, British Guiana, and it is approximately a week before the ship returns. That was the time allotted for my stay in Trinidad. It seems a short period for the accomplishment of much collecting work, but Trinidad is a very remarkable island with a system of good roads giving easy access to the wildest of places. This comes about through the island's inexhaustible supply of asphalt.

Another reason for anticipating the accomplishment of much in a short time was supplied by my good friend, Professor F. W. Urich of Port-of-Spain. He knew how anxious I had been to study the habitat of *Vampyrus spectrum,* which for years has been rare even as preserved material in the larger museums. Professor Urich had written me that in his travels over the island investigating the lairs of the true vampire, or blood-drinking bat, which was spreading paralytic rabies, he had gone to caves, abandoned buildings and great hollow trees of the ceiba or silk-cotton type and found that while vampires slept by day in all of these places, the caves sheltered the greatest numbers and that he had discovered several lairs of the giant bat, *Vampyrus,* in silk-cotton trees. That creature did not appear to be a cave bat. Moreover, it also appeared to live only in pairs in widely scattered trees. "Bat trees" were readily recognized by the tails of rats and feathers of birds, the droppings from the bats' meals, on the floor within the hollow trees. For years *Vampyrus* had been thought to be a fruit-eating bat, although when Linnaeus named it in 1766 its title indicated that he considered it *the* vampire bat. Professor Urich was emphatic in pronouncing it a savage carnivore. At the end of his letter was a sentence that forced my decision to go to Trinidad as soon as I could. It read: "And I have two living specimens of *Vampyrus spectrum* for you—also a young bushmaster which has eaten a dozen mice."

The many stops as the steamer cruised through the West Indies enabled me to make interesting trips ashore. The smaller lizards, mostly Anoles, were the principal objects sought. They run up and down the tree trunks and telegraph poles and, owing to their climbing habits, have escaped near extermination by the mongoose—extermination having been the fate of the terrestrial lizards. At Martinique I gathered further information about the mongoose. On this island and in other parts of the West Indies these animals appear to be deteriorating. I noted several crossing the roads and observed their scant pelage, the tail particularly being almost devoid of hair. It will be fortunate if these pests decrease in numbers, as bird life will again have a chance on the islands. The mongoose has by no means exterminated the fer-de-lance on St. Lucia and Martinique. I heard reports of these snakes on both islands and in some districts they do not appear to be uncommon.

When the *Nerissa* anchored at Port-of-Spain, Professor Urich came out in a tender and assisted me in taking my baggage ashore. We went



All through the daytime the big meat-eating bats hang head downward in the darkest corner of their little cage.

to his house on Charlotte Street, exchanging on the way notes about our mutual studies of the true vampire bat, which has become a problem in the tropics as the known carrier of formidable maladies. The professor's observations are appearing in the government journals of Trinidad. My preliminary paper of considerable length was published in Zoologica earlier this year. On the way to the professor's house I enjoyed in anticipation the opportunity I would have of examining living specimens of the big carnivorous bat.

Professor Urich showed me the young bushmaster captured not far from Port-of-Spain. It was of particular interest as it was the second specimen ever known to feed in captivity. The first had been in the possession of Mr. R. R. Mole, had eaten one mouse, and shortly afterward succumbed to an injury sustained in capture. This had happened more than thirty years ago. The present snake was about thirty inches long, and since I had received the first letter about it, had continued to feed.

We looked along a row of cages containing true vampires, which are rather small bats with a wingspread of not much more than twelve inches. Several were under suspicion of being infected with rabies. One was carrying an infant bat at her breast, partly tucked under her wing. The vampire gives birth to a single young and nurses it in typical mammalian fashion.

"And now," I exclaimed to my friend, "let me take a look at *Vampyrus spectrum.*"

"I'm terribly sorry," he said. "They had a fight and both are dead." He pointed to a high, empty cage. "They were two males, from separate trees. Possibly I should not have put them together up there, but they seemed to be peaceable enough at first."

This was a bitter disappointment. I had my heart set on taking those two giant bats back to the United States and possibly capturing a couple more, but when one is on a tropical island with good friends and native boys to help, one's spirits soon recover.

We had a long conference and I learned that Achi, one of the professor's laboratory assistants, had been dispatched to locate hollow silk-cotton trees and look for traces of *Vampyrus.* This was highly encouraging. Achi was versatile and efficient. His tabulation sheets in the laboratory contained rows of figures and data that looked like copperplate engraving, but he preferred to slip on khaki trousers, sleeveless shirt and battered hat, sling a machete at his belt and steer through jungle areas where he might stay for days.

There was no word from Achi until a telephone message came through to my quarters. He had found a big ceiba with traces of bats and had crawled between the great buttressed roots, shot the beam of his searchlight up the hollow center, had seen two *Vampyrus spectrum* leering down at him.

We rolled away in the morning with Achi in the lead. A huge net of light material bulged from the rear of his car. I was attired for a long hike through thick places, with khaki trousers and shirt and high boots to keep out ticks and red bugs. Achi had told me that the bat tree was somewhere near Four Roads, and although this meant little to me, I was prepared for rough going.

We had not been on the way half an hour when Achi's car pulled to the side of the road and stopped. I stopped immediately behind him.

"Motor go wrong?" I asked him.

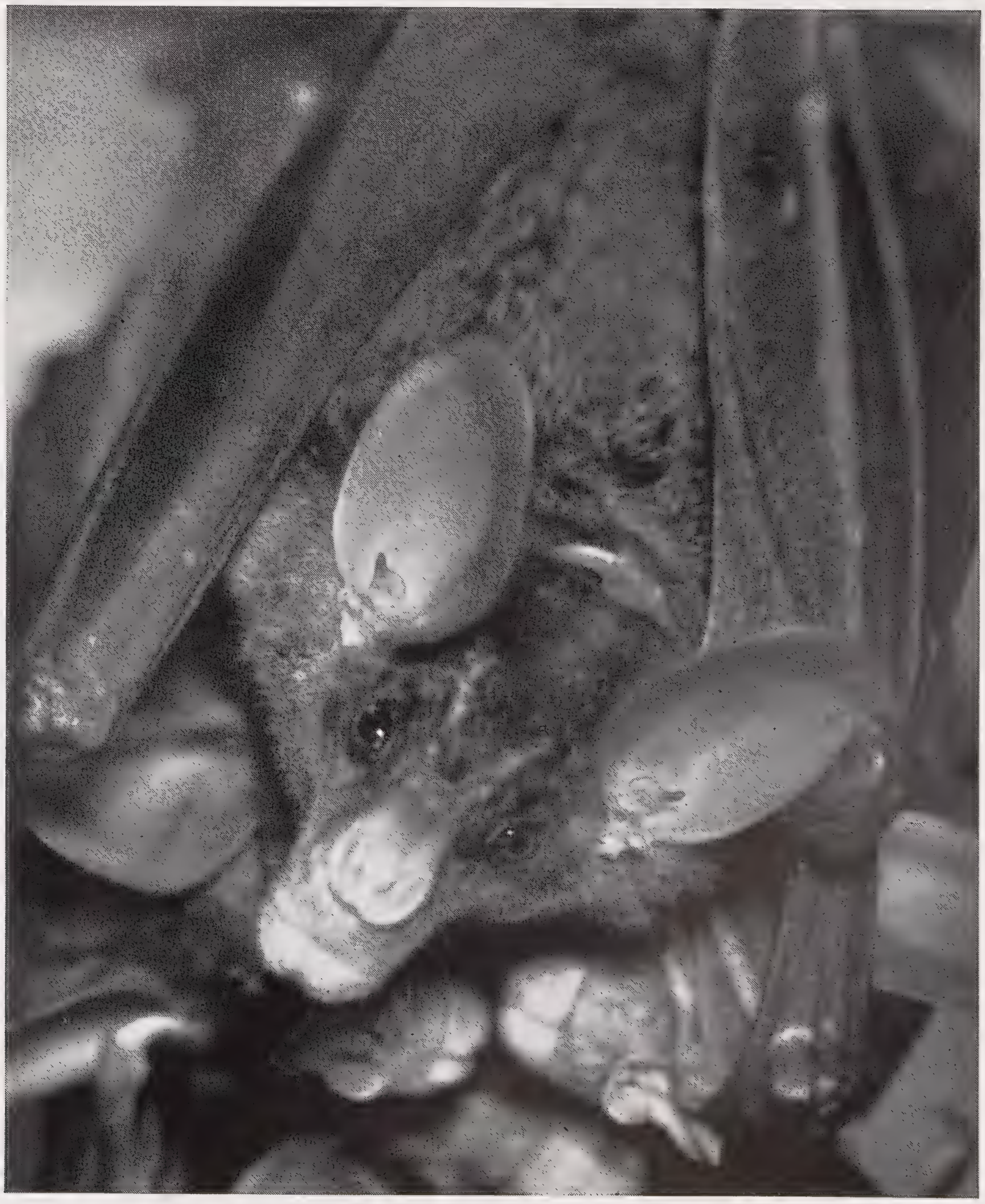
"No," said Achi. "This is the place." He pointed to a big silk-cotton tree not twenty-five feet from the road.

Probably I looked rather stunned, particularly so as a policeman in white tunic and helmet sauntered up to see what we were about. A sign on a booth nearby pointed to the Four Roads constabulary station. The only wild-looking feature of the place was the great tree, the buttressed roots on one side spreading like the entrance to a cave. An interested audience of several cows and a flock of chickens gathered about us and insisted on getting in the way.

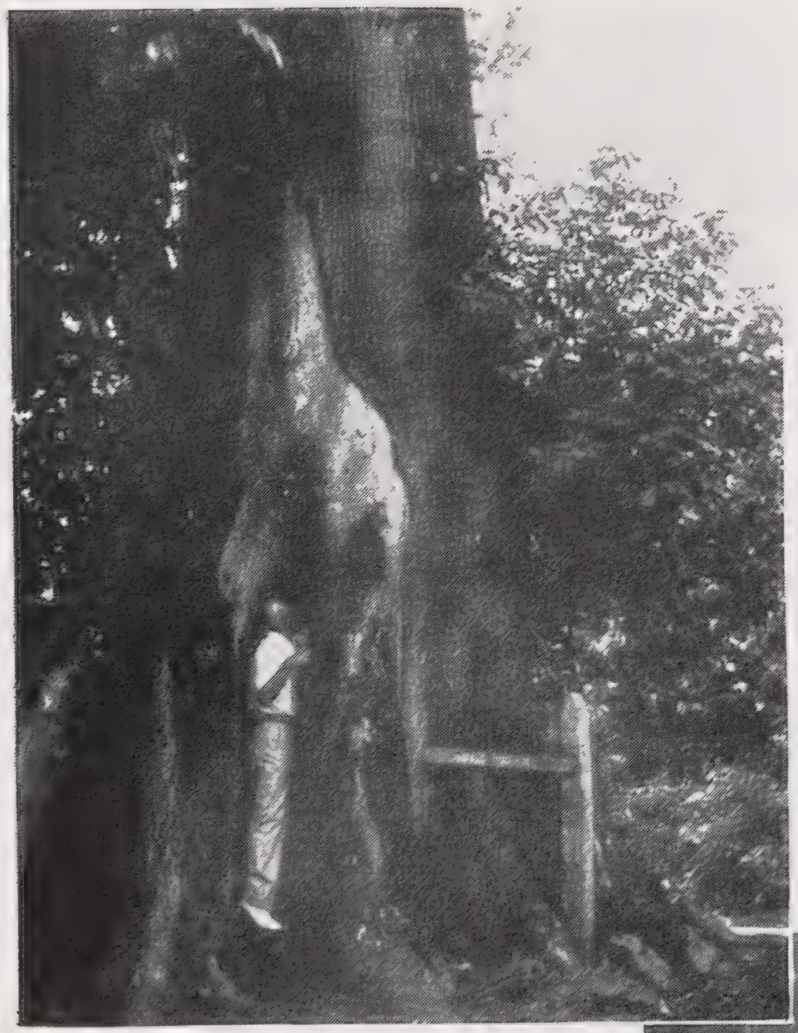
Achi's first precaution was to wind the big net around the base of the tree, then tack it securely over the opening, leaving it loose at the bottom for us to crawl in. We wriggled underneath. There was a central hollow shaft in the tree, about four feet in diameter. My guide carried a long flashlight and he projected the beam directly upward.

Approximately eighteen feet overhead were three big bats, hanging well apart. They were peering down at us and showing strong, gleaming teeth. My first impression of them was of suspended opossums, probably suggested by their long snouts and pinkish faces.

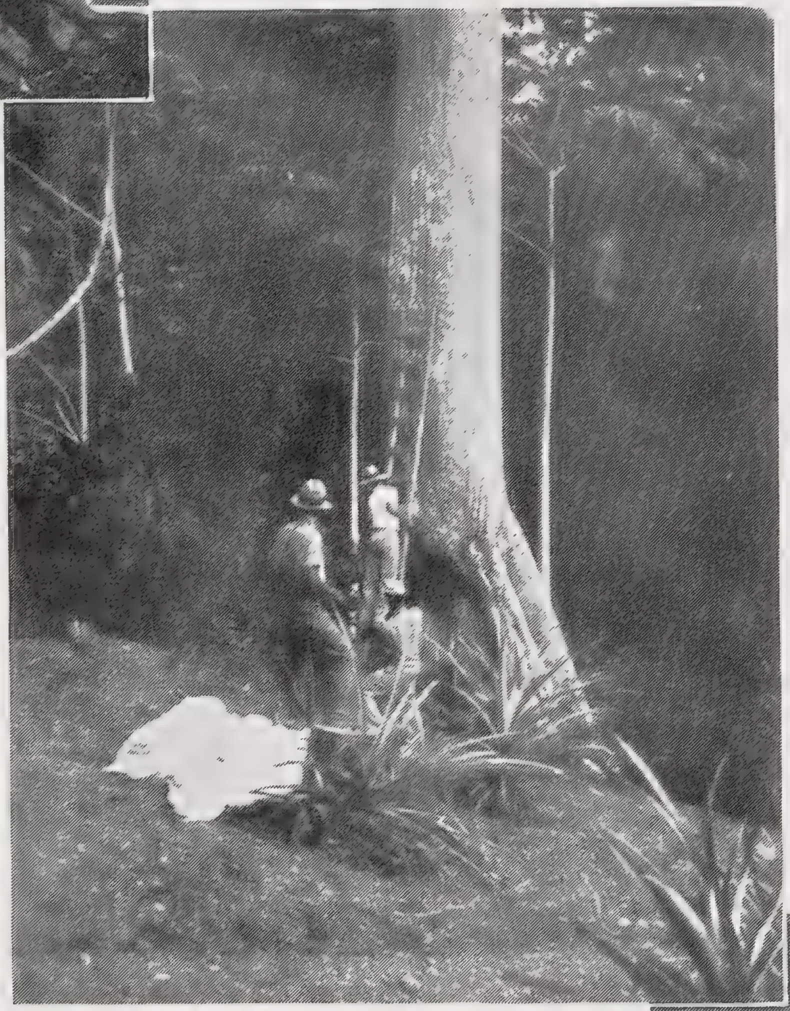
We crawled out again and chopped down a slender sapling, trimmed away the branches and worked this in under the net, together with a small cage. On the floor of decayed wood were the telltale feathers and the shriveled tails of



Huge ears and a long snout give the bat an appearance much different from that of the small insect-eating bats of North America.



The cleft in the hollow trunk of the ceiba was just wide enough for a thin person to enter.



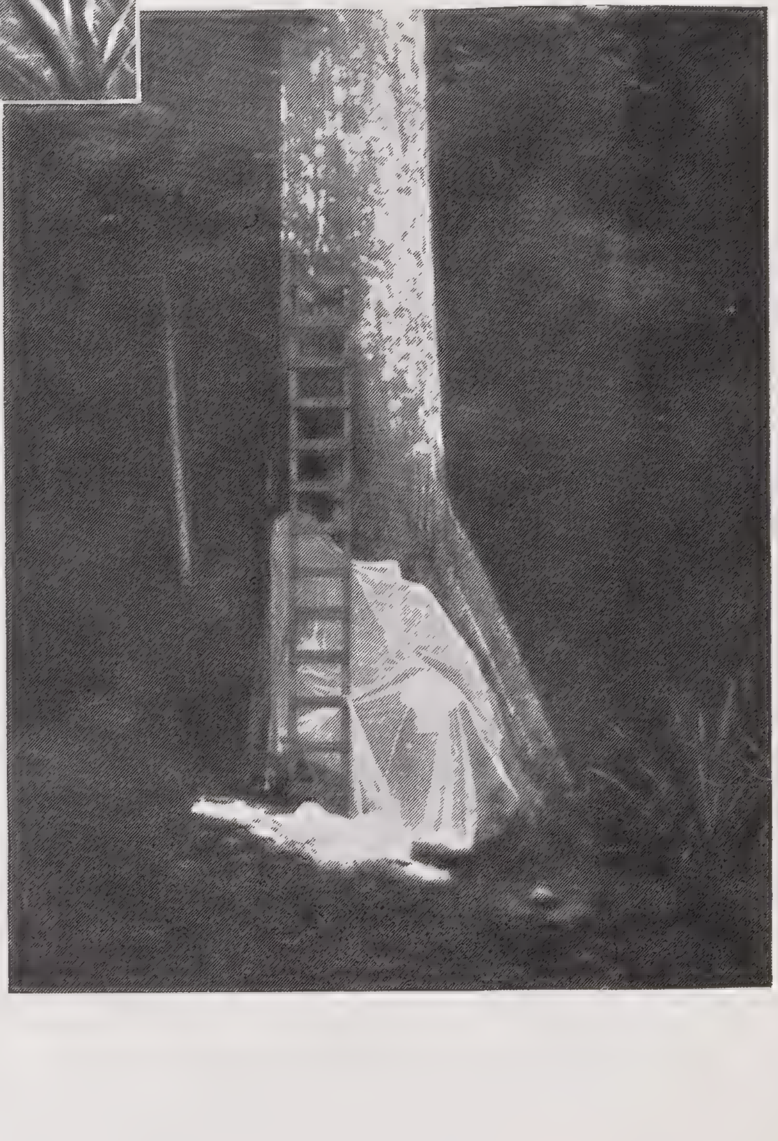
(Right) Entrances to a bees' nest high up on the side of the tree had to be stopped first.

several rats. We were provided with a heavy pair of gloves and these my assistant slipped on. The sapling was used to dislodge the bats.

The electric torch illuminated a strange picture. Using their powerful winghooks and clawed hind feet, the bats started to crawl around the shaft. I was astonished at their spread and breadth of wing. The former appeared to be fully a yard and the wings were relatively very broad. One bat worked down toward us, and there was a sound as of a cat purring. I remarked about this and Achi said the bat was grinding its teeth. He made a grab for its neck, was successful, and turned the creature around for me to see. Its teeth were as large as those of a cat and the outstretched wings enveloped Achi's shoulders. This bat was thrust into the cage and the second was captured in much the same way. When we looked for the third, there was no trace of it, but a hole in the side of the tree showed where it had probably escaped.

I considered the morning highly successful and took several photographs of the tree to illustrate the habitat of *Vampyrus spectrum*. Before doing this I had to drive away the cows and chickens, which seemed rather incongruous on such a quest. The bats were taken to Professor Urich's laboratory and one of his boys was instructed to shoot some birds for them. They fed ravenously the evening following their

(Below) A net was tacked over the open side of the tree for the double purpose of preventing the escape of the bats and keeping the bees out.



capture. Achi assured me he would locate another tree.

When the second tree was found I was informed that it was at Santa Cruz, and my map was examined. I decided that here, again, was an easy trip, and dressed accordingly, in white slacks and a white shirt. We drove barely an hour from Port-of-Spain and stopped in a farming country. The big ceiba was on a jungle-clad hillside and the rough costume of the previous trip would have been better than white clothing. There was the usual opening close to the base of the tree. Achi had squeezed two friends into his little car and they brought up the roll of net, the traveling bat cage and a ladder obtained at a farmhouse. As I was climbing toward the ceiba, the boys shouted to warn me to approach it cautiously because there was a nest of wild bees in the tree. They said these were small stingless bees, but that they could bite. Small biting bees did not seem to me to present any serious difficulty. This decision was almost instantly reversed.

When we were within a few feet of the ceiba the bees came at us like pelting pebbles, and their jaws produced as sharp a pain as a sting—and they were tenacious in their hold. Bravely taking his punishment, one of the boys ran up the ladder, stuffed a cloth into the hole that led to the nest, and poured on some chloroform which had been brought from the laboratory. All three then crawled under the net and, once inside the hollow, fastened the net.

The air was so filled with returning bees which settled in swarms over the net that I decided to risk punishment myself in fastening a cloth on a stick, lighting it and waving it as a smudge. It worked long enough for me to join the boys inside and I hoped it would calm the bees before we emerged.

Conditions inside the hollow were the same as in the first tree. There were feathers on

The largest bats in the world belong to the genus Pteropus—gigantic fruit-eaters capable of ruining a fruit grove in a single night. This picture taken by Dr. C. H. Townsend in the Tonga Islands many years ago shows a protected colony of bats sleeping.

the soft, pulpy floor and overhead hung a pair of the big bats. They were, fortunately, in reach of the jointed handle of a round net and were captured in the same fashion as the first pair.

It was during the struggle to usher the last bat into the cage that the bees won a decisive victory. They found an entrance into the shaft and poured in on us. Our retreat was precipitate and I fear the net was torn as we dashed out. Even the bats were in distress, rolling about the cage and snapping at the clinging insects.

After they rid themselves of the bees, however, they showed no ill effects of their bites.

Between visits to the bat trees I made a trip to the island of Gasparee immediately off the northwest shore of Trinidad, an islet remarkable for its dryness between rainy seasons.

There are several immense ceibas on Gasparee, but we found no lairs of *Vampyrus* in them. However, the famous cave of the island, a tourist attraction, disclosed evidence of habitation by the fish-eating bat, *Noctilio leporinus,* in surprisingly large numbers. There must have been several hundred of them. Deep water blocked our way into a tunnel that led to the smaller cavern where the bats were hanging, but the odor of fish was very strong and many bats flew out while others stayed inside and kept up a continual chattering.

A very large centipede, often attaining a length of fourteen inches, occurs on Gasparee. Apparently it is not found on the mainland, or at least is very rare, possibly because of the existence of natural enemies not found on Gasparee. One comparatively small specimen of the centipede was brought back from Trinidad last summer and is still on exhibition in the Reptile House; on this trip, two more were obtained, each more than a foot long.

On the way to Gasparee I had the pleasure of chatting with Dr. E. J. Sankeralli, the Acting Inspector of Health of the South Division of Trinidad. He pointed out some of his work in malaria control by increasing the salt content of mosquito-breeding marshes—a comparatively simple process of flooding them with sea water by means of ditches. The larvae of the malaria-carrying *Anopheles* mosquito prefer brackish water but cannot endure a salinity approaching that of sea water.

An additional trip was made to Mayaro, by way of one of the world's finest beaches lined by miles of slanting coconut palms. The trip was of particular interest to me as one of the approaches on the fifty-mile drive is along the Nariva lagoon, the haunt of many anacondas. A specimen from that neighborhood, "Big Annie," was once exhibited in the Park. The serpent was nineteen feet long and weighed nearly two hundred pounds.

Before the *Nerissa* returned from Georgetown on the way back to New York, Professor Urich gave me the feeding record of the young bushmaster, *Lachesis muta.* It was captured on February 2, 1935, and I append the professor's notes on its shedding and the number of mice it consumed while under his care—all "wild" mice, captured in a trap:

	Mice Eaten		Mice Eaten
April 2	1	July 24	1
April 3	1	August 1	1
April 4	1	August 2	1
April 5	1	August 10	1
April 11	2	August 14	1
May 3	1	August 15	1
May 6	1	August 25	Shed skin
May 14	1	August 26	1
May 20	Shed skin	August 28	1
June 1	1	August 29	1
June 2	1	September 9	1
June 11	1	September 28	1
June 19	1	September 29	1
June 26	1	October 1	1
July 14	1	October 3	1

On October 6 the bushmaster was locked in his traveling cage and started for New York, arriving at the Park on October 14. He took his first mouse on October 31, almost a month after the last feeding in Trinidad, another on November 5 and a third on November 10.

The snake was about eighteen inches long at the time of capture and increased in length approximately twelve inches during the eight months he was in Professor Urich's possession.

The four specimens of *Vampyrus spectrum* were successfully brought to the Park and while aboard the *Nerissa* were provided each night with freshly-killed pigeons. The big bats are thriving and have become very tame. They seem to regard their traveling cage as a place of retreat in daytime. When they first arrived, this cage was set inside a large display cage, the door of the smaller one having been removed. They explored the large cage the first night but returned to the little traveling cage before morning, and that has been their practice ever since.

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Henry Fairfield Osborn

The Honorary President of the New York Zoological Society, whose death occurred on November 6 at his home at Garrison, N. Y., was one of the small group of men most actively connected with the early years of the Society and one of those who helped to lay down the principles that have guided it.

Almost immediately after the Act incorporating the New York Zoological Society was accepted by the City of New York on April 26, 1895, Henry Fairfield Osborn was appointed to the committee engaged in drawing up the preliminary plan for the work of such a Society. Upon Prof. Osborn and Madison Grant fell chief responsibility for drafting the original plans for the Society and in 1896, while the Executive Committee embodying the active founders was being formed, he was elected its chairman, serving through the important formative years from 1896 to 1903.

He was again able to give the young Society the benefit of his scientific knowledge and experience in the same capacity from 1907 to 1909, in the latter year assuming the presidency of the Society. Upon his retirement in 1923 the Honorary Presidency was bestowed upon him in recognition of more than a quarter of a century of leadership.

Tireless in his efforts to advance knowledge, Prof. Osborn assumed the presidency of The American Museum of Natural History in 1908 and rounded out twenty-five years of creative work in that institution, retiring in 1933 to continue, at leisure, work upon a scientific treatise upon which he was engaged at the time of his death.

Distinguished in the field of paleontology, in which his beliefs have had important effect, he was a member of numerous scientific societies in this country and abroad.

* * *

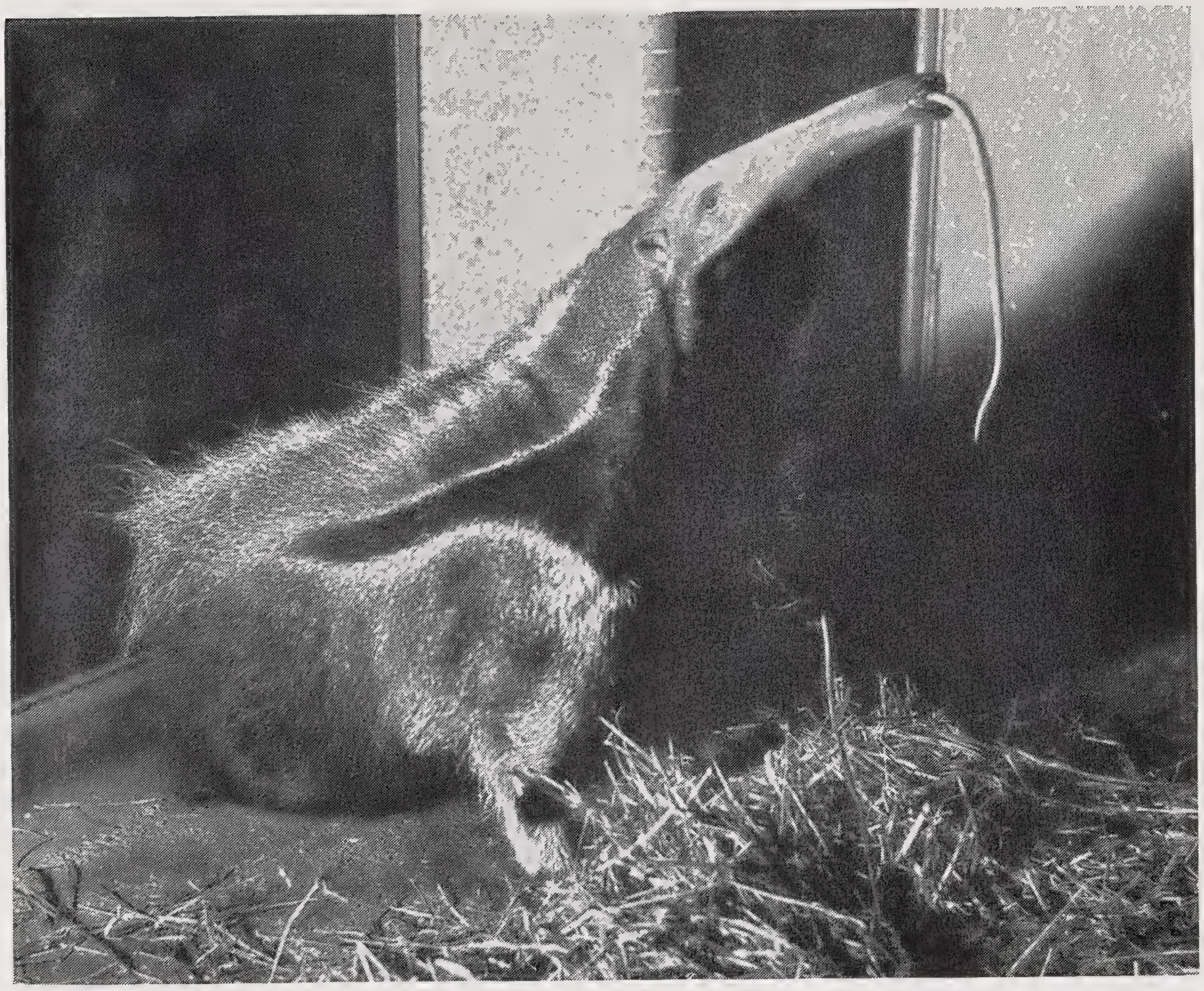
Resolutions expressing the sympathy of the Executive Committee of the Society for the families of the late Edwin Thorne and Grafton H. Pyne were adopted at recent meetings. Mr. Thorne, who died on September 29, had been a member of the Board of Trustees for fifteen years. Mr. Pyne, whose death occurred on October 8, had served as a Trustee for six years.

The Anteater Stretches

Mr. Cully, Keeper at the Small Deer House, has reported an interesting observation on the South American giant anteater. As its name would lead one to suppose, this creature has been designed by nature to feed largely upon ants and other insects, being equipped with strong claws and a long, flexible tongue.

Visitors who happen to be around the Small Deer House at feeding time are greatly interested by the expert way in which the long tongue of the anteater laps up his daily ration of eggs, milk and ground meat. Seeing him in action they can easily understand how, in his native forests, a slight flick of the tongue could do away with any insect that should happen to cross his path. But what the visitor misses is the astonishing length of this organ, a characteristic that formerly could be noted only upon rare occasions.

Mr. Cully has discovered that our present anteater goes through a remarkable series of setting-up exercises whenever he is awakened from a sound sleep. Stretch after stretch rivals the best effort of the laziest house cat. In addition, the long tongue is extended time and time again to its greatest length—twenty inches or more—for a moment, and then it is withdrawn



When the great anteater awakens from a sound sleep, he first stretches himself like a cat and then thrusts out his long tongue its full length.

into the mouth. One wonders where all the tongue can possibly come from, and as for going back, there just can't be room enough! But back it goes.

After the animal has enjoyed a nap, curled up in a compact ball, we are more or less prepared for the stretching process, but we are totally unprepared for the limbering up of the tongue that goes with it. As one visitor remarked, "I'd hate to have that fellow give me a tongue lashing!" C.W.L.

Heron in the Hospital

A period of unseasonably warm weather in October so rejuvenated the elderly goliath heron that it attempted to fly out of its paddock and as a result has been spending several weeks in the hospital recuperating from a broken leg.

The paddock is surrounded by a seven-foot fence and the bird managed to climb to the top, using wings and toes, but in attempting to take off in the direction of complete liberty it caught its toe in the fence and fell, snapping one long leg.

The fracture appears to be healing nicely and the bird will soon be returned to its winter quarters in the Aquatic Bird House. On Christmas Day it will have been in the Park 23 years—a period of longevity in captivity that exceeds by five years the longest longevity record for *Ardea goliath* in any other zoological park. Curator Crandall brought the bird back from Amsterdam, the offspring of a breeding pair, on Christmas Day, 1912.

Guests for the Winter

The black ducks that have been wintering on the Wildfowl Pond for years are coming in about on schedule. Forty or fifty spent the summer here and probably bred here; by September 20 arrivals from the North increased the population to 250. They came in slowly for about three weeks and then came more rapidly as the northern lakes froze over. At present the Bird Department is having to feed about 600 ducks, with a good prospect of two or three hundred more coming in the next week or so.

Bitter Enders

Emphasizing the cold loneliness of the big Flying Cage since its summer occupants of aquatic birds were taken indoors early in October, two silver gulls remained inside and for several weeks defied every effort to capture them.

Every other bird had been transferred from the cage to winter quarters by October 16, but the gulls refused to go into the small cage-trap and flew to the highest perches when they thought their liberty was being assaulted. A cage with a one-way entrance was finally left inside and liberally baited. One gull was tempted inside by an attractive display of sliced butterfish, but for more than a week its companion's fancy and appetite were completely satisfied by popcorn tossed into the big cage by visitors. But popcorn palled and the gull hungered for fish. The Flying Cage is empty now.

Under the Fence Is Out

A visitor who reported to a gateman that an animal "too large to be a muskrat" was paddling around in Lake Agassiz gave the first news, late in October, of the course taken by three beavers that had escaped from their supposedly escape-proof pond.

When the Beaver Pond was constructed many years ago a trench from four to eight feet deep was dug around the entire pond and filled with concrete, and on this a stout fence was set. The concrete was believed to rest on bedrock at every point, but apparently there was a gap at one spot—and the beavers found it. They dug a tunnel under the concrete and waddled off to a succulent grove of young ash and willow trees on the shores of Lake Agassiz.

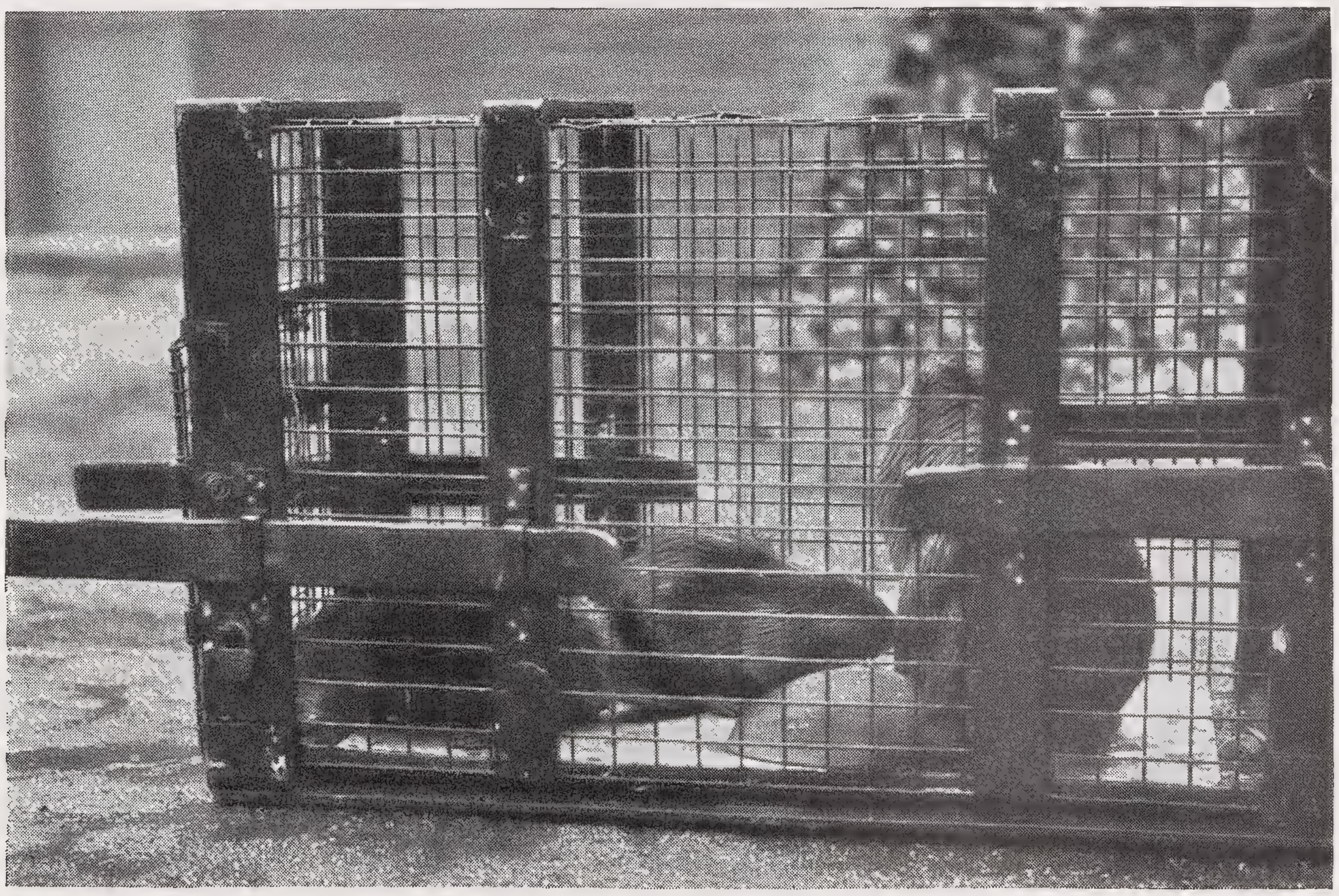
A cage baited with corn was set immediately but they avoided it for several days and managed to fell a four-inch ash and girdle four other small trees before they investigated the trap and were caged. Keepers Romanoff and Taggart dropped the door of the cage after waiting for four hours one night, and carried them back to their own pond. In the meantime the tunnel under the concrete had been filled in and it will take super-beaver ingenuity for them to dig out again.

Their depredations along Lake Agassiz were not a total loss. Curator Crandall had been looking for a young tree for perches in one of the flying cages and the beaver-felled ash turned out to be exactly the right size.

Simba Is Not Musical

Several times in the past musicians, psychologists and, it is to be feared, just plain publicity seekers, have made efforts to prove the old belief that "music hath charms to soothe the savage breast." They have played the violin for snakes, the saxophone for the lions and tigers, the bass viol for the elephants. A woman with a beautiful operatic soprano gave a recital in the Bird House one afternoon, and on another occasion a man with a harmonica entertained the parrots for the greater part of a day.

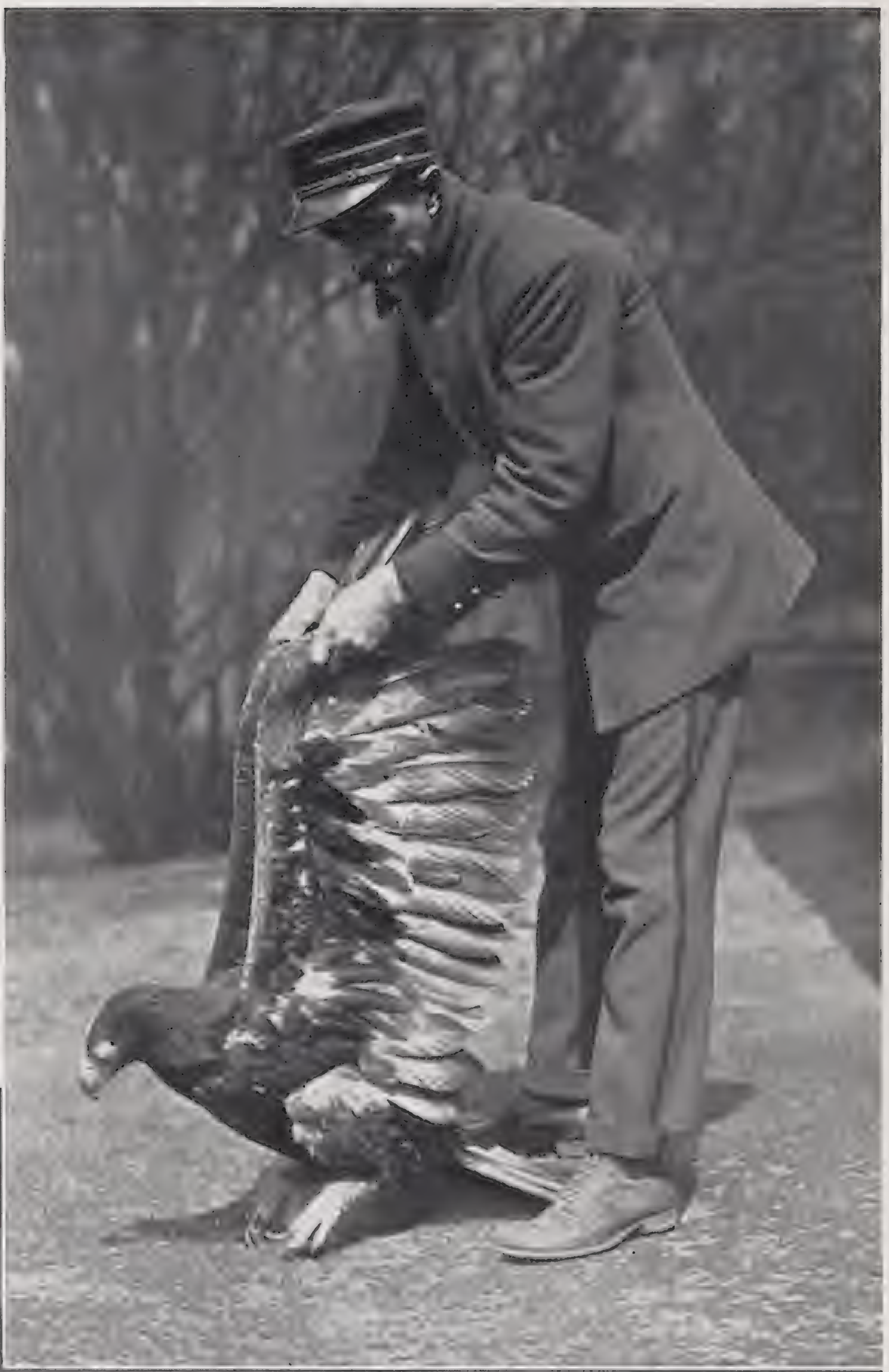
He was the only one of the musicians who really managed to get the birds to take any visible interest in his art. A yellow-nape Amazon parrot danced a few slow, grave steps as if trying to keep time to the tune. It seemed to be one authentic instance of an animal responding to music—except that the yellow-nape Amazon was known to be in the habit of going through those same steps on any or no occasion.

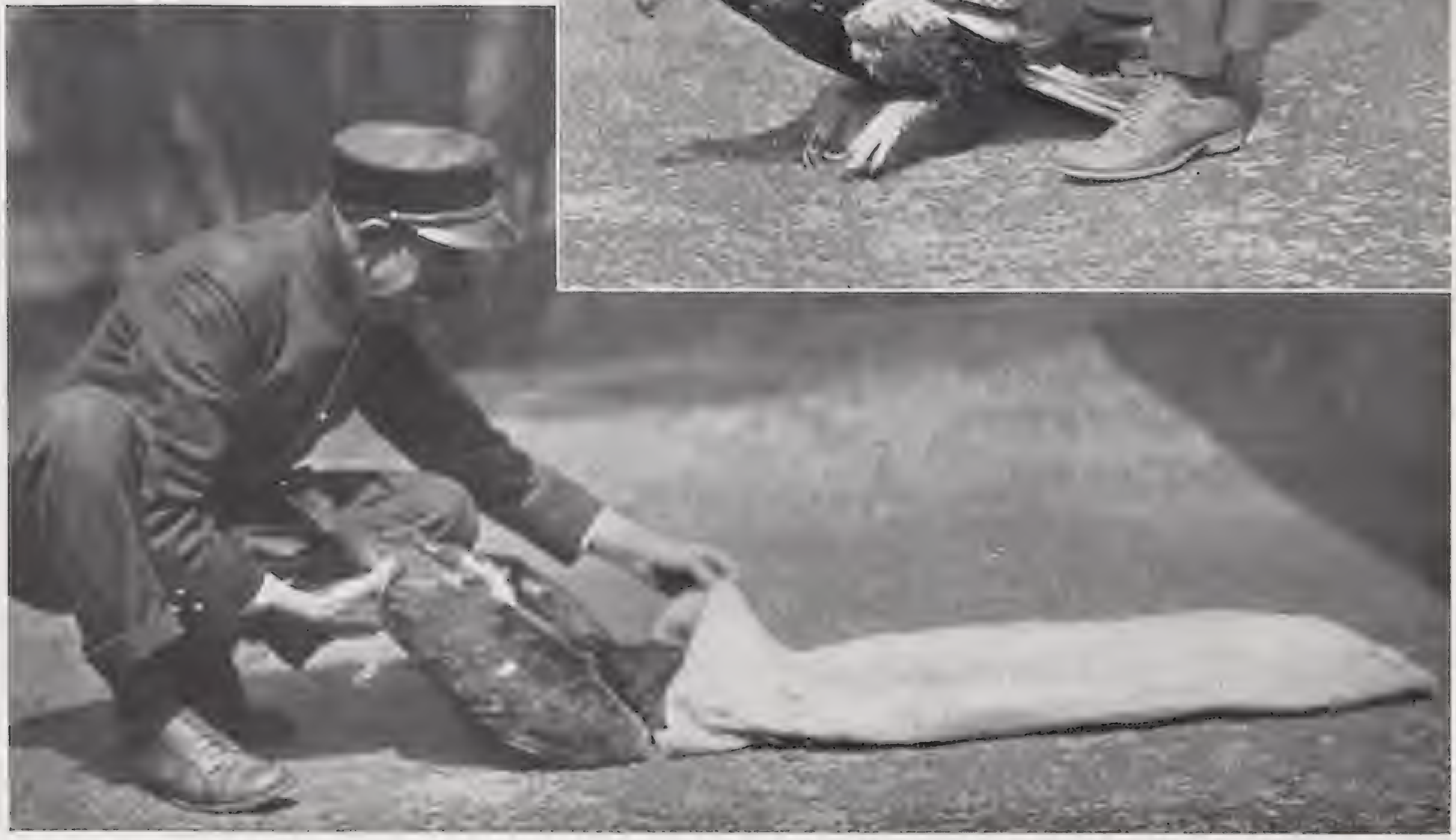


The Park's wandering beavers walked out of their enclosure by themselves, but they rode home.

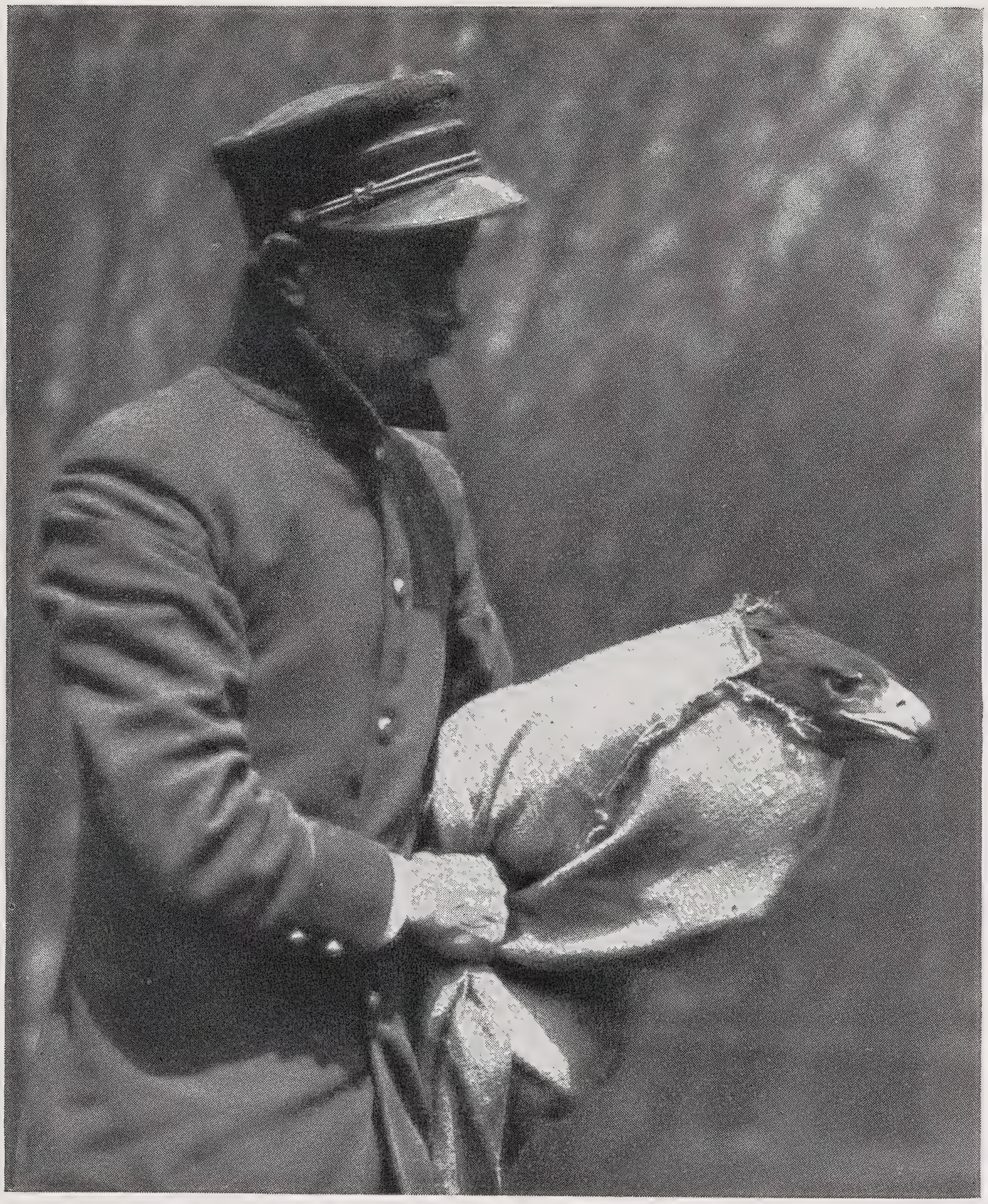
In restraining animals for examination or surgical treatment, the Keepers try to do their work with a minimum of handling. These pictures show a simple method of restraining a golden eagle that required an operation to clear up an infection in the region of its left eye.

Standing behind the bird, the Keeper grasped the ends of its wings to immobilize it and prevent injury to the bird and himself.





The next stage is to lower the eagle's wings against the side of its body and hold them there firmly but gently while the bird's tail and legs are grasped in one hand. The Keeper then places the bird in a burlap sack, one corner of which has been cut off to provide an opening for its head. With its wings and legs confined, the bird is not likely to make any very serious struggle to free itself, and the Keeper has complete control over it.



When the eagle's head is protruding from the sack it is ready for examination and operation. Its body is securely wrapped in the burlap and there is no danger of its powerful wings or talons causing injury.

As a result of the operation performed in this case by Dr. Noback, a lesion was drained and the bird's displaced eyeball returned to its normal position as healing took place.

It was suggested recently that the animals might respond to percussion instruments and rhythm, even though they had shown no interest in strings, reeds or the human voice. Curator Crandall took a native drum into the Lion House to experiment with its effect on Simba, the young lion.

The drum is a hollow cylinder of wood with a piece of snakeskin stretched across the head. Made by a Kuni tribesman in New Guinea, Mr. Crandall brought it back among the souvenirs of his expedition to collect birds of paradise.

Standing just inside the Lion House door, twenty feet from Simba's cage but out of sight, Mr. Crandall struck the drum with the flat of his hand, in native fashion. The hollow boom thus produced caused an immediate effect among the occupants of all the cages. The lions, tigers, jaguars and cheetahs instantly faced the end of the room whence the startling noise was coming. Young Simba had been sleeping, but he bounced to his feet and stared intently in the direction of the sound.

Mr. Crandall continued to strike the snakeskin, first in a steady beat of 96 strokes to the minute, and then a more subtle, more complicated rhythm he had learned from the New Guinea natives.

Simba's interest manifested itself for about a quarter of a minute. He stared fixedly toward the hidden drum-beater, perhaps to satisfy himself that the loud noise meant no harm. He turned away indifferently and stared into space, turning back to watch with no particular interest when Mr. Crandall emerged from behind the door and stood in full view within a few feet of the front of the cage. Mr. Crandall varied his rhythms, beat all the native signals he knew. It was no use. Simba lay down and went to sleep again. The other animals did the same.

"*Two Boys in White Pants*"

Leaving the Park late one autumn evening, a member of the staff was accosted by a pedestrian at the Southern Boulevard gate. The man was excited.

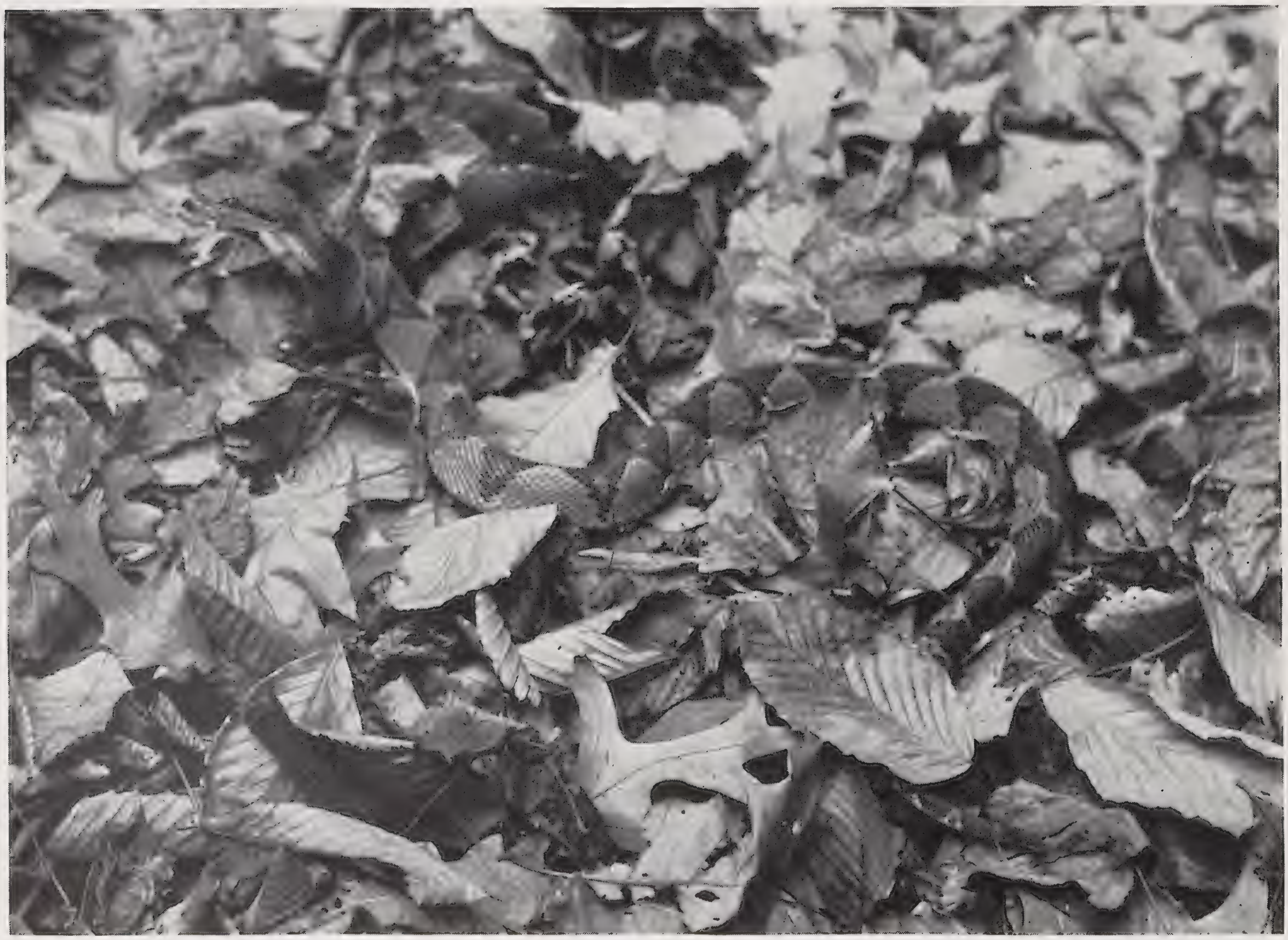
"Somebody's in with the deers, chasing them around," he reported. "I looked through the fence, and I think it's two boys in white pants. You'd better get them out before they get hurt."

The Park man agreed that if somebody actually was in the deer range, they had better be removed in a hurry. He investigated. The range in question was the one occupied by the fallow deer. The "two boys in white pants" turned out to be one of the albino deer trotting over the range in a playful mood.

Book of Interest

HOLIDAY SHORE. By Edith M. Patch and Carroll Lane Fenton. 150 pages with 48 illustrations. The Macmillan Company, 1935. $2.

As an introduction to the commoner creatures of the sea shore, "Holiday Shore" is admirably adjusted to the interests and curiosity of children of about eight years. With plenty of photographs and drawings to make identification certain, it talks simply about the jellyfish and sea anemones, hermit crabs and king crabs, barnacles and sea horses, and many others that make up the little fascinations of the beach and tidal pool. The style of writing befits juvenile readers but the information about the lives and habits of the creatures is accurate and clear.



In its native jungle the bushmaster is extremely difficult to see because its copper-and-black color blends so perfectly with the decayed leaves on the forest floor. This picture shows how the snake manages to efface itself among autumn foliage.

PUBLICATIONS

Free to Members:

Bulletin: The official publication of the New York Zoological Society reports bi-monthly on interesting phases of work at the Park and the Aquarium and contains articles on natural history in a sound yet popular form, with many illustrations. Thirty-seven volumes have been completed.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I-IX and XI-XVIII are complete, and other volumes are in preparation. Zoologica is illustrated, and is published as material is presented. It is sent to Members on request.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I is completed and Volume II is in preparation. It is illustrated, appears when material is available, and is sent to Members on request.

Annual Report: Documents, reports and pictures of the work of the various departments of the Park and the Aquarium. As a rule it contains articles of scientific value and considerable general interest.

Gallery of Wild Animal Paintings in the Zoological Park: A handsomely illustrated catalogue of the gallery in the Administration Building at the Park, which Members may receive on request.

Some Books by Members of the Park Staff:

Beebe: Half Mile Down. 344 pages, 123 illustrations and 8 colored plates. 1934. $5.

An account of the deep-sea explorations of the Department of Tropical Research in the bathysphere.

Blair: In the Zoo. 195 pages, 55 illustrations. 1929. $2.50.

Entertaining and informative animal stories drawn from long experience in the Zoological Park.

Crandall: Paradise Quest. 226 pages, 52 illustrations. 1931. $3.50.

A vivid description of a successful expedition to New Guinea in search of Birds of Paradise for the Park collection.

........: Pets and How to Care for Them. 296 pages, 96 illustrations. 1930. $2.

A practical manual for everyone who keeps animal or bird pets.

Ditmars: Confessions of a Scientist. 241 pages, 39 illustrations. 1934. $3.50.

Adventures in collecting and maintaining animals in the Zoological Park.

........: Snakes of the World. 207 pages, 84 pages of illustrations. 1931. $5.

A comprehensive book of reference on the snakes of the world.

Leister: Present Day Mammals. 74 pages, 106 illustrations. 1931. $1.

A valuable classification and reference book for schools and students of zoology.

All these books and others by the same authors may be obtained from the New York Zoological Park. For book express add 15 cents postage for each volume.

A classified list of the publications of the Society, with subject headings of articles printed in the *Report, Zoologica* and *Zoopathologica,* as well as reprints from them, will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Orders for any of the publications should be addressed to H. R. Mitchell, *Manager, Zoological Park,* 185th street and Southern Boulevard, New York City.

No effort will be spared to ensure delivery of the regular publications to Members of the Society, but changes of address, forwarding points and non-delivery of mail should be reported promptly. Back numbers of *Bulletin* still in print will be supplied to Members and others at the rate of 30 cents each. Postage 3 cents extra.

Clark and Fritts, New York, Printers.

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